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Contract DA-44-177-AMC-121(T)

31 January 1964

XV-8A
FLEXIBLE WING AERIAL UTILITY VEHICLE

REPORT NO. 64B082

(Jan 64)

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Prepared by
RYAN AERONAUTICAL COMPANY
SAN DIEGO, CALIFORNIA

for
(U. S. ARMY TRANSPORTATION RESEARCH COMMAND
FORT EUSTIS, VIRGINIA 23604)

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XV-8A Aircraft in Flight

FOREWORD

This Report has been prepared by the Ryan Aeronautical Company, 2701 Harbor Drive, San Diego, California per TRECOM Regulation as revised, and as authorized under Contract DA-44-177-AMC-121(T) on 31 January 1964.

The Report discusses the XV-8A Flight Test Program. The project was supported by the Advance Research Projects Agency of the Department of Defence and was monitored by the U. S. Army Transportation Research Command. All Testing was conducted at the Yuma Proving Grounds, Yuma, Arizona between 5 February 1964 and 28 April 1964. Airborne test activity at that locale provided aircraft support and work space facilities.

This document was authored by H. Kredit, Flight Test Engineer, and approved by P. Girard, Project Engineer.

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SYMBOLS

Symbol	Units	Nomenclature
A	ft ²	Area (for XV-8A = 450 ft ²)
AR		Aspect Ratio b^2/S
a	ft/sec ²	Acceleration
b	ft.	Wing Span (for XV-8A = 33.4 ft.)
BHP	550 ft. lb/sec	Actual Brake Horsepower
BHP _{CH}	550 ft. lb/sec	Chart Brake Horsepower
CAS	MPH	Calibrated Airspeed
C _D		Drag Coefficient
C _{D_o}		Parasite Drag Coefficient
C _{D_i}		Induced Drag Coefficient
C.G.		Center of Gravity (STA.)
C _L		Lift Coefficient
D	LB	Drag
e		The square Root of Oswald's Span Efficiency Factor
F	LB	Force
g	32.2 ft/sec ²	Acceleration Due to Gravity
H (h)	ft	Absolute Altitude (Tapeline)
H _D (h _d)	ft	Density Altitude
H _p	ft	Pressure Altitude

SYMBOLS (Continued)

Symbol	Units	Nomenclature
ΔH_{p_e}	ft	Altimeter Position Error Correction
ΔH_{p_i}	ft	Altimeter Instrument Error Correction
IAS	MPH	Indicated Airspeed
i_w	DEG	Wing Incidence Angle
MAP	in. Hg	Manifold Pressure
OAT	° C	Outside Air Temperature
P	in. Hg.	Atmospheric (static) Pressure
ΔP_p	in. Hg.	Static Pressure Error
q	lb/ft ²	Dynamic Pressure
R/C	ft/min	Rate of Climb
R/D	ft/min	Rate of Descent
RPM	1/min	Engine Revolutions per Minute
S	ft ²	Wing Area
S	ft	Takeoff or Landing Distance
t	Min	Time
T	° K	Temp. in Degrees Kelvin (° C + 273)
TAS	MPH	True Airspeed
V	MPH (ft/sec)	Observed Airspeed
ΔV_i	MPH (ft/sec)	Airspeed Instrument Error Correction
V_i	MPH (ft/sec)	Indicated Airspeed, $V_o + \Delta V_i$

SYMBOLS (Continued)

Symbol	Units	Nomenclature
ΔV_{p_e}	MPH (ft/sec)	Airspeed Position Error Correction
V_c	MPH (ft/sec)	Calibrated Airspeed $V_1 + \Delta V_{pe}$
ΔV_c	MPH (ft/sec)	Compressibility Correction
V_e	MPH (ft/sec)	Equivalent Airspeed $V_c - \Delta V_c$
V_T	MPH (ft/sec)	True Airspeed, $V_e / \sqrt{\sigma}$
V_g	MPH (ft/sec)	Ground Speed
W	lb.	Weight
W_f	Gal/Min	Fuel Flow

Subscripts

a	Aileron
c	Compressibility, Corrected
ch	Chart
d	Density
e	Elevator, Equivalent
ew	Equivalent Weight Designation
g	Ground
i	Indicated, Instrument
o	Observed, or sea level standard
p	Pressure, Propeller
r	Rudder

SYMBOLS (Continued)

Symbol	Units	Nomenclature
s		Standard Conditions or Standard Values
t		Total
w		Wind

Greek Symbols

α	Degree	Angle of Attack
β	Degree	Angle of Sideslip
δ	Degree	Control Surface Deflection
η	—	Propulsive Efficiency
γ	Degree	Flight Path Angle to the Horizontal
ρ	Slugs/ft ³	Mass Density
σ	—	Density Ratio, ρ/ρ_0
ϕ	Radians	Wing Tip Helical Path Angle
ψ	Degree	Angle of Yaw
μ	—	Coefficient of Friction

SUMMARY

The purpose of this test program was to determine the performance characteristics, the over-all handling qualities, and to establish the operational flight envelope of the XV-8A Flexible Wing Aerial Utility Vehicle.

Standard performance, stability and control flight testing techniques were employed during all phases of operation. Airborne oscillograph recordings and pilot-observed instrument readings were used for data acquisition. A Fairchild Flight Analyzer camera was used to measure take-off and landing distances.

The handling characteristics of the aircraft are good. Control harmony between the longitudinal and lateral control systems is excellent, enabling the aircraft to be flown with one hand. Stability in all cases is positive with only light forces required. The flight characteristics of this airplane are similar in most respects to those found in a conventional airplane with a comparable light wing loading.

The performance capabilities of the airplane are all within predicted values. The cruise capability is such that a 100-mile mission can be flown at maximum gross weight. Take-off and landing performance proved the STOL capability of the airplane. At maximum gross weight, the take-off distance over a 50-foot obstacle is 1,000 feet. Landing distance to clear a 50-foot obstacle is 400 feet.

During the course of the test program, the airplane proved a reliable and easy aircraft to maintain and service. Some test operations were conducted from unprepared desert surfaces, establishing the capability for operation from areas other than regular airfields.

The operational and flying techniques are basically similar to lightweight conventional aircraft. The two-control system lends itself to simplicity and provides adequate control power to permit a fixed wing incidence trim setting for the entire flight including take-off, climb, cruise, descent, and landing.

RGAT

CONCLUSIONS AND RECOMMENDATIONS

1. The aircraft is safe and pleasant to fly for a pilot of average skill. Data available indicates that, with improvements, the concept can be developed into a flying truck with reduced experience and skill requirements for the operator. Helicopter and light plane experience aids in transition to this aircraft, although such experience is by no means necessary.
2. The aircraft is capable of very rough field operation with certain advantages over fixed wing aircraft or helicopters.
3. The idea of a primitive, low-cost, low-maintenance, limited-performance but useful aerial device was clearly demonstrated. For example, only one operation out of 47 was delayed due to aircraft maintenance. This program did not represent an operational evaluation environment, however the low maintenance and support required was very unusual for an experimental aircraft.
4. The aircraft met or exceeded all predicted performance goals, and demonstrated its ability to haul bulky cargo shapes and a useful load almost equal to its empty weight.
5. Safe landing characteristics with engine power at idle were demonstrated.
6. The system is highly sensitive to turbulence and rough air which is uncomfortable, but is self-damping to a high degree. The wing appears to lose lift in some conditions of turbulence causing some degradation of climb and descent performance.
7. Cross wind operation investigations were continuously conducted. The results suggest that limitations will eventually be established that are quite compatible with light aircraft of about the same weight.
8. The ability of the aircraft to operate as a light STOL utility vehicle with a 100-mile range was established.

OVER

9. Additional flight testing, such as wing-fixed investigations, three-control system effects, heavy wing batten installation and more complete stall per performance checks should be conducted.
10. The concept of piloted, powered flexible wing vehicles appears very promising as a result of this program. Continued development by the U. S. Army also appears desirable, considering present requirements and the fast moving conceptual changes in air mobility. END
11. D. R. Simon, a U. S. Army TRECOM pilot, was checked out in the XV-8A in a three-day period at the end of the test program. His two hour and 50-minute flight time included operation throughout the flight envelope, and a number of taxi runs and landings under wind conditions from calm to 15 knots. This pilot's experience and reactions established the relative ease with which the system lends itself to pilot qualification.

INTRODUCTION

The XV-8A aircraft, (designated FLEEP by this Contractor), resulted from Ryan Aeronautical Company design studies of the application of the Rogallo flexible wing concept to a manned aircraft. This aircraft is an improved version of the original Ryan Flexible Wing manned test vehicle.

The aircraft was designed as a single place, lightweight utility vehicle, capable of carrying a 1000-pound payload and having short field take-off and landing characteristics.

The primary purpose of the test program was to determine the flight characteristics, performance capabilities, and to establish an operational flight envelope for the aircraft. Special attention was directed toward determining the adequacy of the longitudinal control system for performing the landing flare maneuver with idle power.

DESCRIPTION OF XV-8A VEHICLE

GENERAL

The description of the XV-8A Aircraft is divided into four major categories:

1. Wing
2. Fuselage/gear
3. Tail
4. Power plant

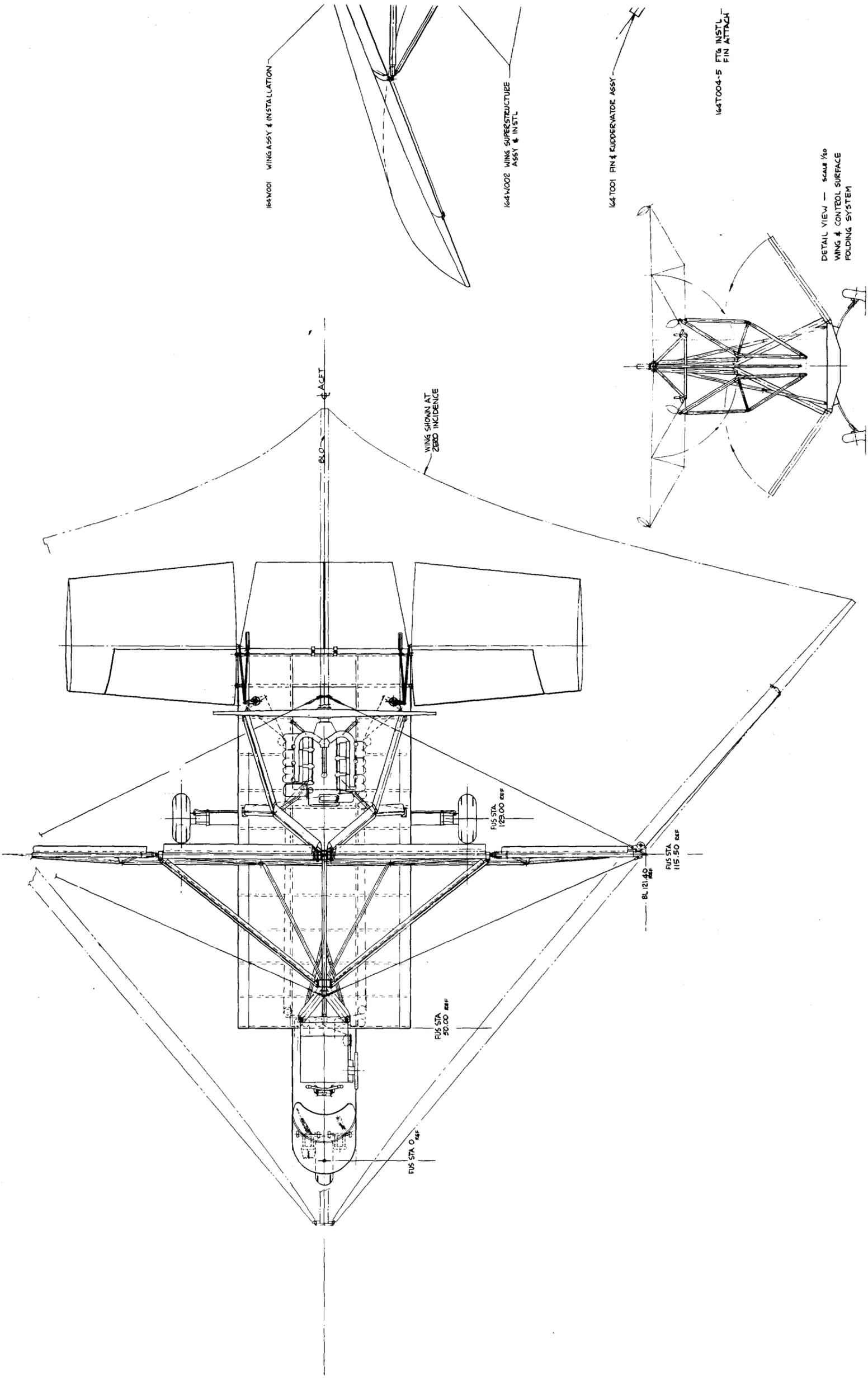
and four minor additional categories:

5. Control system
6. Fuel system
7. Electrical system
8. Cockpit instruments

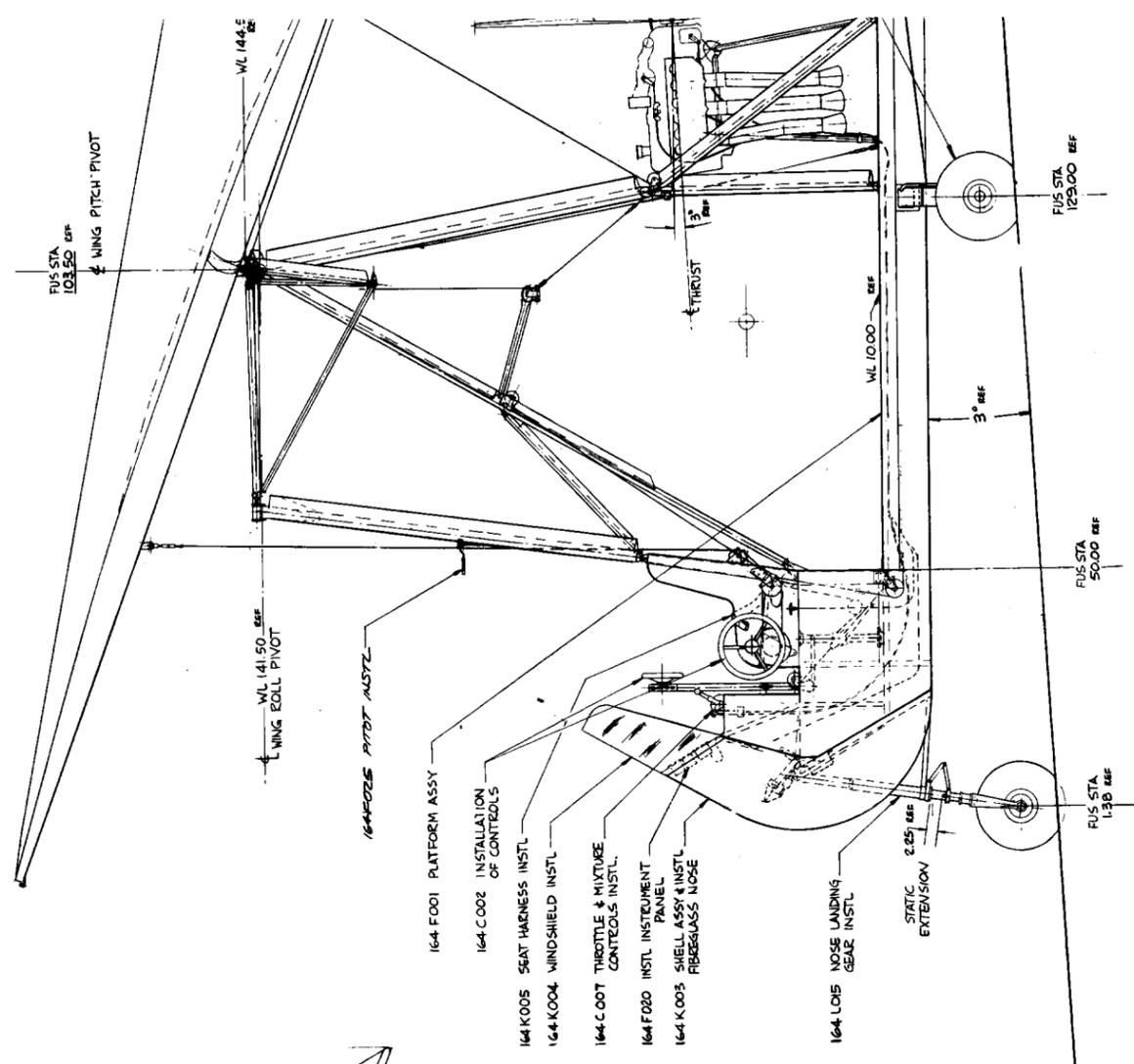
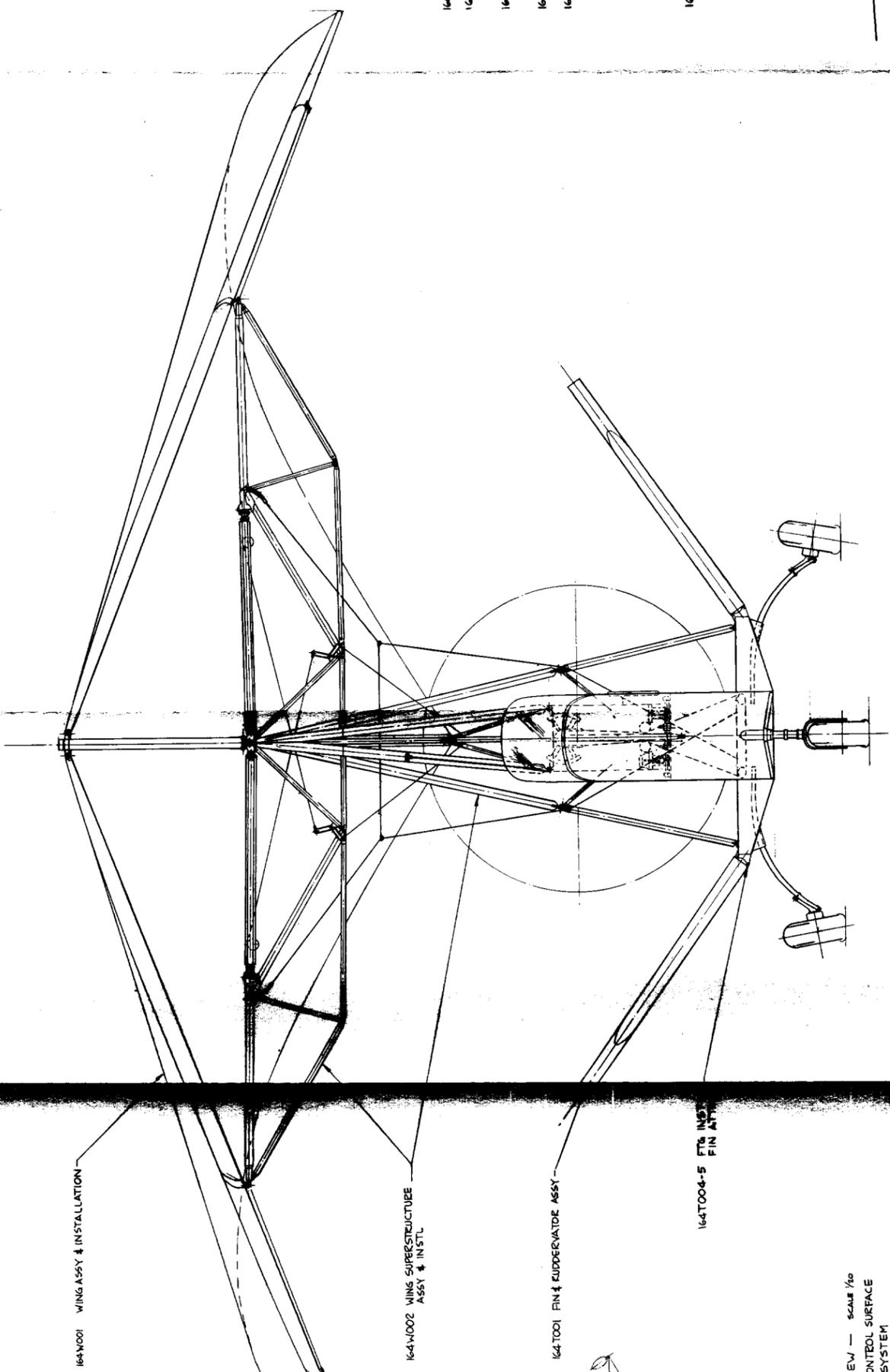
A three-view general arrangement drawing is shown in Figure 1. As noted on the drawing, the wing pitch pivot point was moved forward 12 inches from Fuselage Station 115.5 to Fuselage Station 103.5. This modification was made prior to the start of the test program.

WING

The wing is composed of three main structural members: a rigid center keel, and rigid right and left leading edges. The two leading edges join the keel at the apex and form a near-triangular wing plan form. The keel runs longitudinally aft from the apex along the center line of the wing. The flexible membrane, made of Dacron with a polyester coating, is continuously attached to the leading edges and keel. The leading edges have a 50° sweep angle. The total wing area in flat planform is 450 square feet.

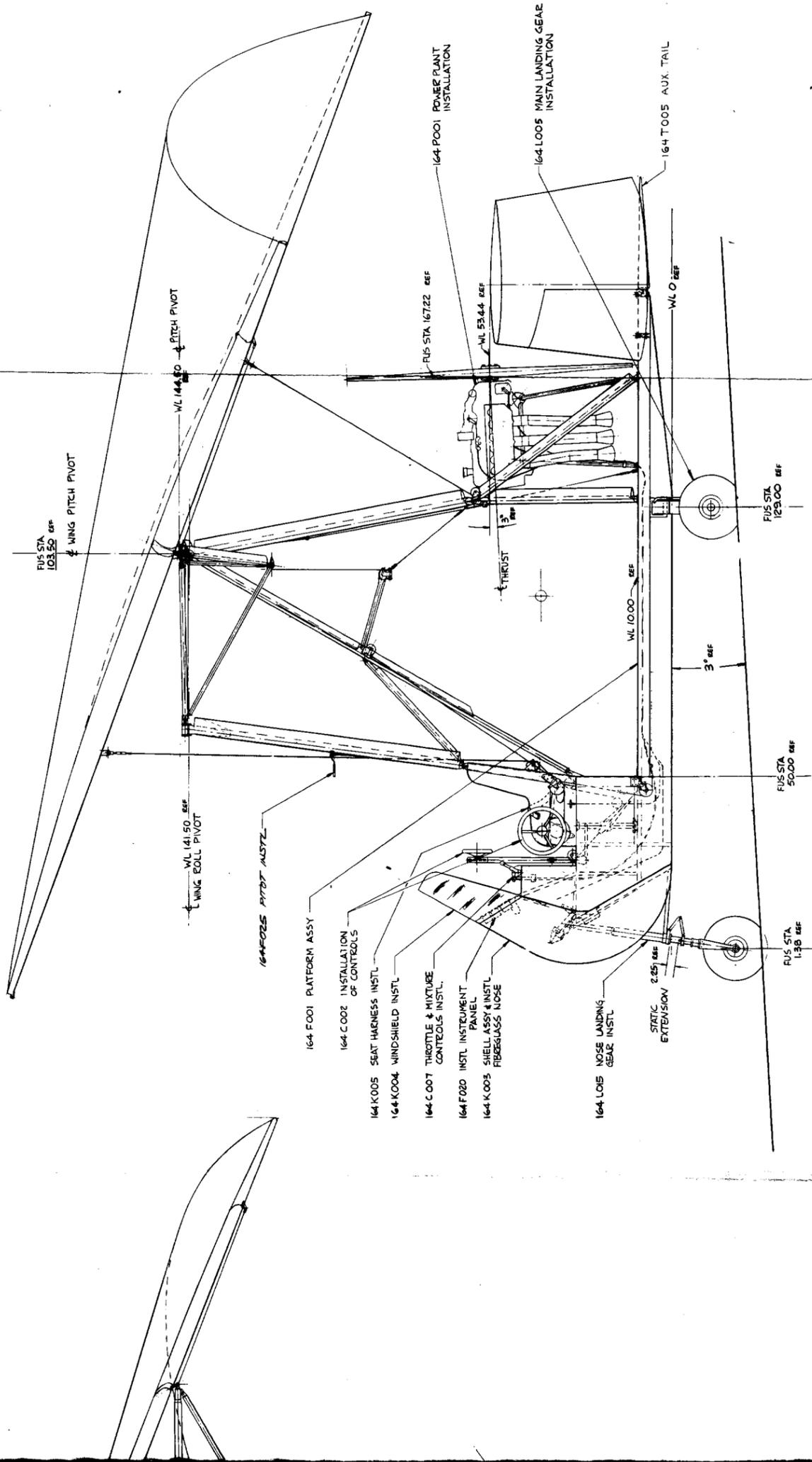


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DETAIL VIEW — SCALE 1/10
WING & CONTROL SURFACE
FOLDING SYSTEM

(2)



GENERAL INFORMATION

- WING AREA - 450 sq. FT.
- KEEL & L.E. LENGTH - 26.0 FT.
- MAX. SPAN - 33.4 FT.
- L.E. SWEEP ANGLE - 50°
- T.E. SCALLOP - 6% WING AREA
- TOTAL TAIL AREA (TRUE) - 51.0 sq. FT.
- MOVABLE SURFACE AREA (TOTAL) - 34.78 sq. FT.
- AIRFOIL SECTION - NACA 0012
- DIHEDRAL - 35°
- POWER PLANT - IO-360-A (CONTINENTAL)
- PROP DIAMETER - 7.0 FT.
- LANDING GEAR WHEELBASE - 127.60 INS.
- TRACK - 108.00 INS.
- TIRE SIZE - 700X6 TYPE III (L.P.)

7

Figure 1. XV-8A Three-View Drawing

3

The wing support structure is a truss system made of aluminum tubing. The streamlined aluminum spreader bar and supporting structure are so designed and hinged as to permit the leading edges to be folded aft along the keel to facilitate ground handling and storage.

The wing is capable of being rolled $\pm 7 \frac{1}{2}$ degrees laterally, and moved from 0 to 30 degrees incidence angle relative to the platform.

FUSELAGE/GEAR

The fuselage is basically a rectangular platform of conventional riveted sheet metal construction. The platform supports the wing support structure, engine, pilot cockpit and landing gear. The platform has a cargo loading area of 36.75 square feet. The main landing gear suspension is a single leaf spring of fiberglass construction, semi-cantilever mounted from the cargo platform. The nose gear mounted forward at the pilot's cockpit is steerable and has a conventional oleo-type shock absorber. Brakes are provided on both main wheels and are actuated by a single toe-operated pedal mounted atop the right rudder pedal.

TAIL

The tail is a U-type with a 35 degree dihedral, and it is cantilever-mounted on the outer edges of the aft extension of the cargo bed. The stabilizers are hinged at the platform to enable folding inboard for ground handling and storage. The movable surfaces attached to the stabilizers incorporate an overhand balance system. In addition, a horizontal elevator is attached to the aft end of the fuselage. The total tail area is 62.93 square feet, with a total movable surface area of 46.70 square feet.

POWER PLANT

A Continental IO-360A fuel injection engine rated at 210 brake horsepower at 2800 rpm is mounted on a tubular frame in a pusher installation on the aft end of the platform. The engine is equipped with a seven-foot diameter Hartzell constant speed propeller operated in fixed pitch. No starter or generator is installed on the engine.

CONTROLS

The airplane is equipped with a two-control system with the capability of converting to a three-control system. This entire test program was flown with the two-control system.

Longitudinal trim is provided by changing the wing incidence angle with respect to the fuselage platform. A trim wheel located on the left side of the pilot's cockpit allows for pilot actuation during flight. The pitch setting is automatically locked when not in use.

The lateral control system is actuated by a control wheel mounted on the upper end of the control column. The first twenty-five degrees of wheel deflection actuates the hinged tips of the wing leading edges. Further control wheel deflection moves the entire wing laterally with respect to the fuselage. A ground adjustable bolt rope running through the trailing edge of the wing fabric is the only means of lateral control trim.

FUEL SYSTEM

A twenty-eight gallon fuel tank is located in the interior of the center section of the platform. An engine driven fuel pump is used to supply fuel to the engine. An emergency fuel shut-off valve is located in the pilot's compartment. Throttle and mixture controls are located on the left side of the cockpit.

ELECTRICAL SYSTEM

There is no electrical system on the aircraft other than the engine magnetos. Electrical power for the instrumentation system and radio was provided for by conventional storage batteries which were part of the instrumentation system.

COCKPIT INSTRUMENTS

The following engine and flight instruments are located in the cockpit: oil and fuel pressure, oil and cylinder head temperature, tachometer, manifold pressure, outside air temperature, airspeed, altimeter and rate-of-climb indicator.

Table 1. General Information - XV-8A Aircraft

Wing Area	=	450 sq. ft.
Keel and L. E. Length	=	26.0 ft.
Maximum Span	=	33.4 ft.
L. E. Sweep Angle	=	50°
T. E. Scallop	=	6% Wing Area
Total Tail Area (true)	=	62.93 sq. ft.
Movable Surface Area (total)	=	46.70 sq. ft.
Airfoil Section	=	NACA 0012
Dehedral	=	35°
Power Plant	=	IO-360-A (Continental)
Prop Diameter	=	7.0 ft.
Landing Gear Wheelbase	=	27.60 inches
Track	=	108.00 inches
Tire Size	=	700 x 6 Type III (L. P.)

INSTRUMENTATION

GENERAL

The objective of the instrumentation task on the XV-8A aircraft was to measure dynamic loading of principal structural members of the aircraft, as well as obtaining data for flight performance analysis. This was accomplished by the use of strain gages fastened to the structural members to measure stress, linear potentiometers to measure relative motion of wing, tail and other control surfaces. Accelerometers measured g forces, and a vertical gyro measured aircraft attitude. Measurements were recorded on two oscillograph recorders.

RECORDING EQUIPMENT

Points, methods of measurement and record readability are described in Table 2.

Two standard 26-channel Consolidated Engineering Corporation oscillographs were used to record the structural and flight data. Power for the recorders was supplied by two storage batteries. The recorders operated for approximately one hour, which was sufficient time for each flight operation.

Signals were processed through six signal conditioner boxes located adjacent to the recorders.

Figure 2 shows the recording equipment layout on the aircraft. The transducer signal voltage was supplied from the storage batteries through a special 16-volt regulator, (Figure 3). The signal conditioner boxes provided signal attenuation, signal balance and resistance calibration for the signals from the transducers.

Record identification and test event marks were made with a telephone dial connected to each recorder, by dialing the flight numbers and event numbers on the telephone dial, pulses appeared on both recording tapes at the start of each flight and record event. An event switch located on the left side of the pilot's wheel was used to indicate periodic events during a test run. The event voltage also indicated the level of the reference or signal voltage.

MEASURING INSTRUMENTS

Foil-type strain gages were secured with epoxy cement to the aircraft. Multi-pin connectors were placed in the signal cables to allow the aircraft to be disassembled without cutting wires.

Special brackets held the potentiometers for incidence angle, roll angle, elevator angle, and aileron angle. An eight-foot boom was secured to the left side of the aircraft platform which protruded beyond the nose of the aircraft. The boom was used for static and pitot pressure to record airspeed, as well as to support the wind vanes and the potentiometers for angle of attack and side-slip. Special strain gage force rings measured pitch and roll cable loads.

Three linear accelerometers were installed on a special mounting, and were located at the cg of the aircraft. These accelerometers measured vertical, lateral, and longitudinal forces on the aircraft during flight, as well as during take-off and landing operations.

The vertical gyro was self-erecting, with potentiometer output from the pitch and roll gimbals. The gyro was carefully aligned with the longitudinal axis of the aircraft to eliminate cross-coupling effects with the roll channel when pitch was introduced in flight.

INSTRUMENTATION SYSTEM ACCURACY

Accuracy of the instrumentation system is a function of the calibration of each transducer, and accuracy of the signal voltage. Each transducer was calibrated by direct loading, or bridge resistance substitution. The deflection of the signal at each recorder was adjusted to give a voltage excursion which established the record readability found in Table 2 following.

Table 2. Measurements, Recording Methods Recording Readability

<u>MEASUREMENT</u>	<u>TRANSDUCER</u>	<u>RECORDING METHOD</u>	<u>RECORD READABILITY</u>
Bend. Keel, Pivot	Strain Gage	Oscillograph	<340 psi
Shear Keel, Aft. Pivot	Strain Gage	Oscillograph	<340 psi
Bend. Keel, Vert. Apex	Strain Gage	Oscillograph	<340 psi
Comp/Ten. Keel, Apex	Strain Gage	Oscillograph	<340 psi
Shear Keel, Fwd. Pivot	Strain Gage	Oscillograph	<340 psi
Bend. Lead. Edge, Pivot	Strain Gage	Oscillograph	<270 psi
Comp/Ten. Lead. Edge, Pivot	Strain Gage	Oscillograph	<270 psi
Comp/Ten. Spread. Bar, Horiz.	Strain Gage	Oscillograph	<100 psi
Comp/Ten. Spread Bar, Diag.	Strain Gage	Oscillograph	<100 psi
Comp/Ten. Cent. Strut	Strain Gage	Oscillograph	<240 psi
Comp/Ten. Fwd "V" (R)	Strain Gage	Oscillograph	<240 psi
Comp/Ten. Fwd "V" (L)	Strain Gage	Oscillograph	<240 psi
Comp/Ten. Aft "V" (R)	Strain Gage	Oscillograph	<240 psi
Comp/Ten. Aft "V" (L)	Strain Gage	Oscillograph	<240 psi
Angle Wing, Pitch	Potentiometer	Oscillograph	. 10 deg
Angle Wing, Roll	Potentiometer	Oscillograph	. 80 deg
Angle Wing, Tip	Potentiometer	Oscillograph	. 32 deg
Angle Ruddervator	Potentiometer	Oscillograph	. 23 deg
Angle Attack	Potentiometer	Oscillograph	. 28 deg
Angle Sideslip	Potentiometer	Oscillograph	. 28 deg
Angle Roll, Free Space	Potentiometer	Oscillograph	<1. 0 deg
Angle Pitch, Free Space	Potentiometer	Oscillograph	<1. 0 deg
Acceleration Platform "X"	Strain Gage	Oscillograph	. 02 "g"

Table 2. Measurements, Recording Methods Recording Readability (Continued)

<u>MEASUREMENT</u>	<u>TRANSDUCER</u>	<u>RECORDING METHOD</u>	<u>RECORD READABILITY</u>
Acceleration Platform "Y"	Strain Gage	Oscillograph	.02 "g"
Acceleration Platform "Z"	Strain Gage	Oscillograph	.04 "g"
Vibration, Tail Surface	Strain Gage	Oscillograph	.02 "g"
Load Pitch Cable	Strain Gage	Oscillograph	<1.0 lb
Load Roll Cable (R)	Strain Gage	Oscillograph	<1.0 lb
Load Roll Cable (L)	Strain Gage	Oscillograph	<1.0 lb
Flow Fuel Line	Freq. Meter	Oscillograph	<.285 gpm
Pressure, Oil	Panel Inst.	Pilot	<2 lb
Temp, Oil	Panel Inst.	Pilot	<5 deg
Temp, Outside Air	Thermo.	Pilot	<1.0 deg
Temp, Cylinder Head	Panel Inst.	Pilot	<5 deg
Pressure, Altitude	Panel Inst.	Pilot	<25 ft
Pressure, Airspeed	Panel Inst.	Oscillo & Pilot	<.5 mph
RPM, Engine Speed	Panel Inst.	Pilot	<50 RPM
Rate, Rate of Climb	Panel Inst.	Pilot	<100 fpm
Pressure, Manifold	Panel Inst.	Pilot	<.1 in hg
Force, Roll Control	Strain Gage	Oscillograph	<1.0 lb
Force, Pitch Control	Strain Gage	Oscillograph	<.5 lb
Force, Pitch Trim	Strain Gage	Oscillograph	<1.0 lb
Position, Roll Control	Dial	Pilot	<2.0 deg
Position, Pitch Control	Dial	Pilot	<2.0 deg

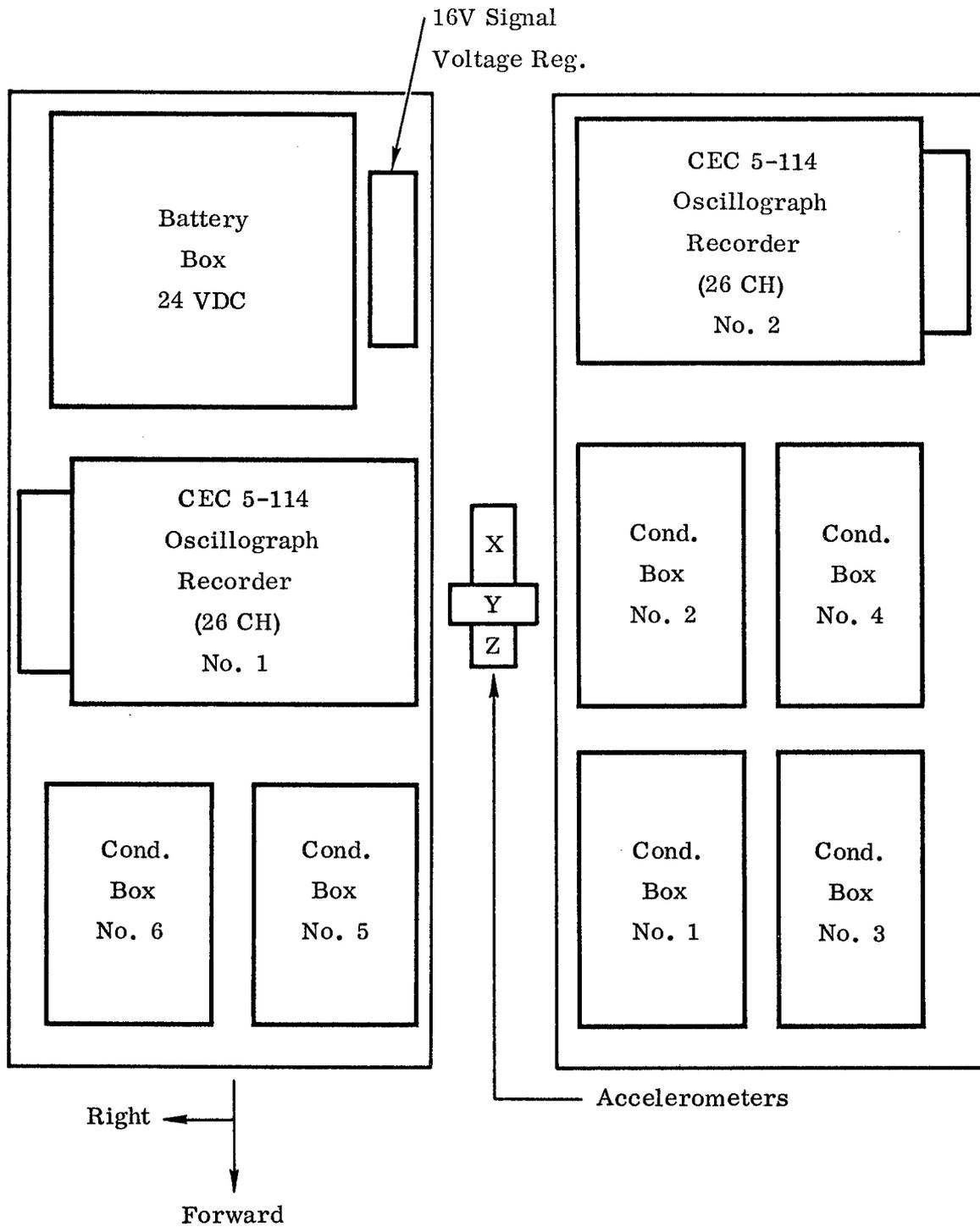
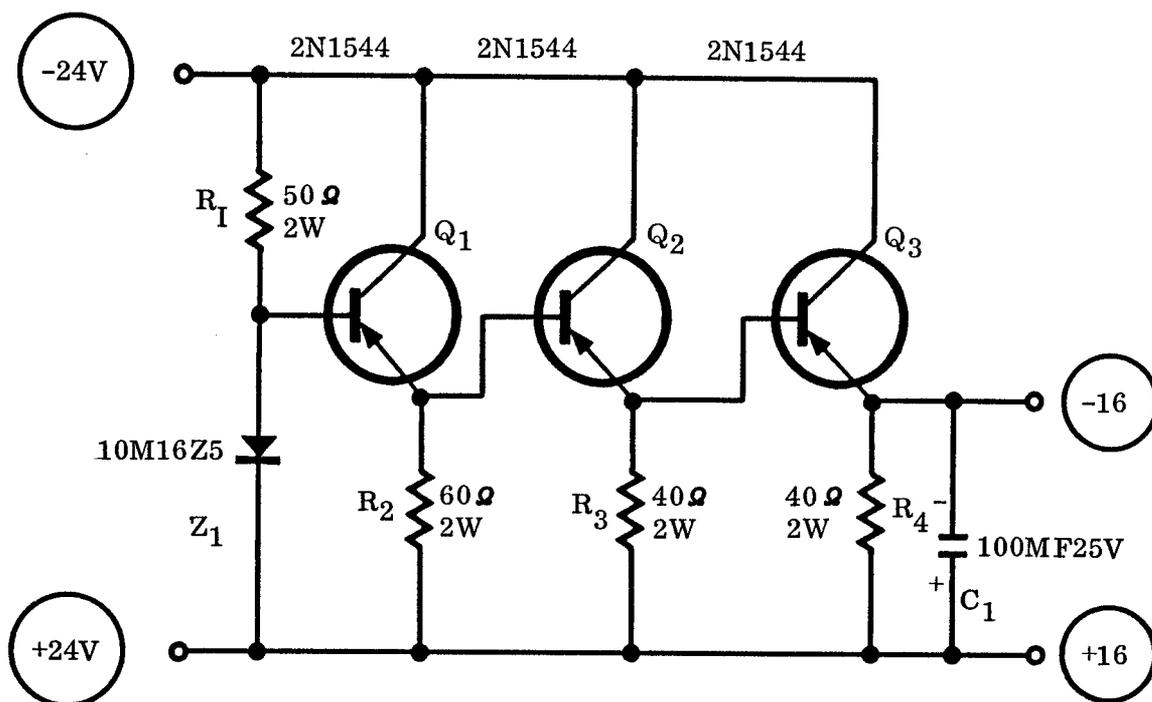


Figure 2. Recording Equipment



Note: R_2 may be Divided to Change Output Voltage

Figure 3. Strain Gage Signal Regulator

TEST PROCEDURES

The flight test procedures used throughout the flight test program were mostly standard, and are applicable to all low speed, lightweight aircraft. On-board oscillographs recorded stability and control data including loads, forces, deflections, etc. The majority of performance data were obtained from pilot-observed records.

Due to the small speed range of the airplane, (10 to 15 miles per hour) normal data scatter would often mask an attempted two to four miles per hour airspeed change. Consequently, test results reflect fewer data points throughout the speed range than that normally obtained when testing a more conventional type aircraft with a larger speed envelope.

Weight and balance checks were made by weighing the aircraft on three platform scales. The center of gravity was controlled by shifting the instrumentation pallet fore and aft on the cargo platform.

TEST RESULTS

PERFORMANCE

Airspeed Calibration

Airspeed position error correction was obtained by using the ground speed course method. Constant speed runs were made over a known course length, and true speed obtained from time and distance data. Calibrated airspeed obtained from true airspeed was compared to the airspeed indicated by the aircraft pitot-static system, thereby obtaining the airspeed position error correction. From this data, the static pressure error was obtained which was used to determine the corresponding altimeter position error. Figures 4 and 5 show the airspeed and altimeter position error corrections respectively.

An attempt was made to verify this data by using the altimeter depression or tower fly-by method for determining the static pressure error. Since this method lends itself more favorably to high speed aircraft, poor correlation and an excessive amount of data scatter was obtained. Consequently, the position error correction curves as presented reflect only the results of the ground speed course method.

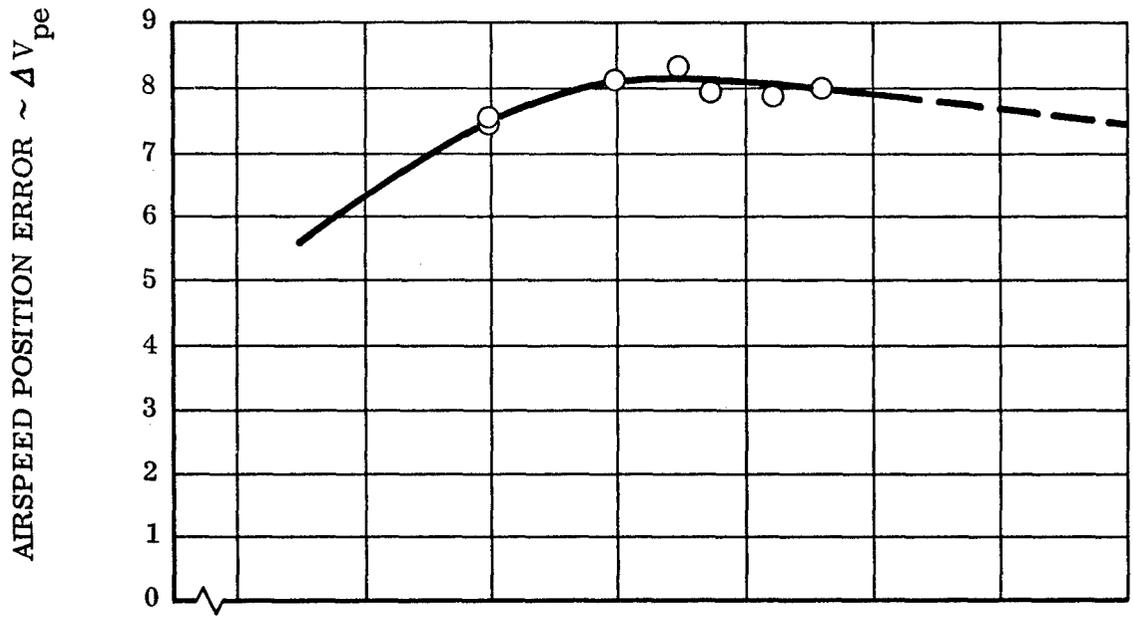


Figure 4. Airspeed Position Error Correction

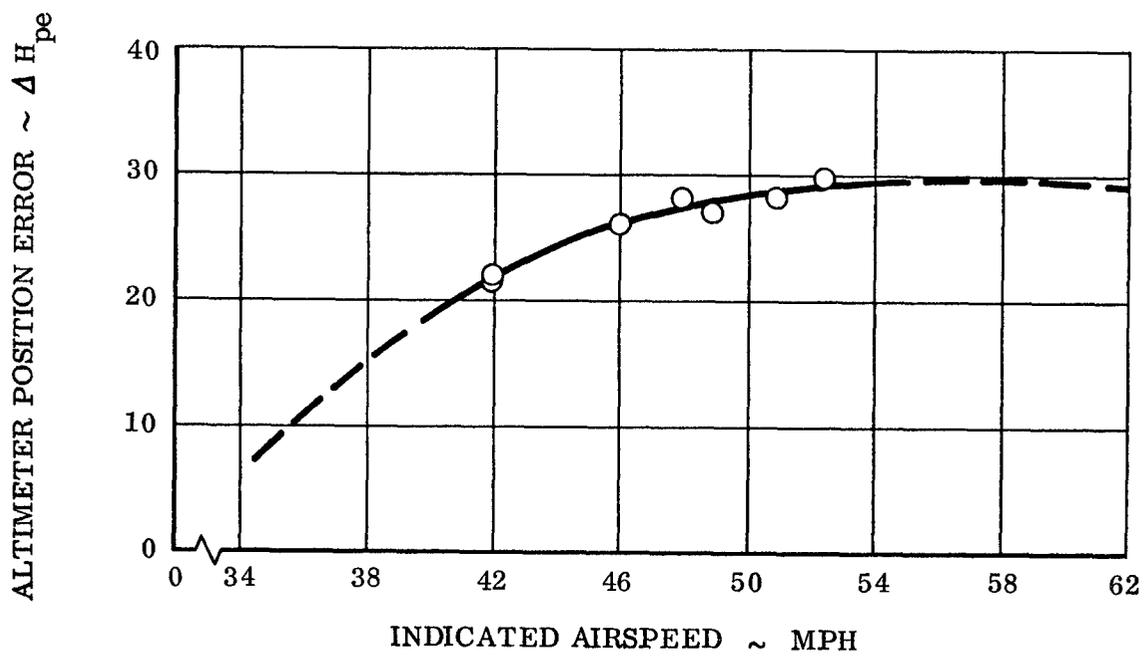


Figure 5. Altimeter Position Error Correction

Take-off and Landing Performance

The XV-8A take-off and landing performance tests were conducted at two gross weights; 2300 pounds and 2000 pounds. A Model IV Fairchild Flight Analyzer was used as the principal source of data acquisition for the establishment of take-off and landing distances over a nominal 50-foot obstacle.

All testing was conducted using Runway 35 at the Yuma Proving Ground. Ballons indicated the 50-foot obstacle height to the pilot. The Fairchild flight analyzer was set up on a concrete aircraft parking pad at an offset distance of 1300 feet from the centerline of Runway 17-35.

A total of seven take-offs were made; three at heavy gross weight and four at light gross weight. A total of eleven landings were photographed; three at heavy gross weight and eight at light gross weight. In all cases, the wind conditions were calm, and the ambient pressure and temperature produced a resulting density altitude close to standard sea level conditions. This was considered to be sea level standard, without the need for application of corrections to standard conditions.

Plotted time histories of the take-off and landing flight paths were made from the Fairchild Flight Analyzer records. The ground run and air distances were determined for a nominal fifty-foot obstacle clearance.

Tabular data for take-off and landing performances are presented in Tables 3 and 4, respectively. A single summary presentation of take-off and landing performance is presented in Figure 6.

Take-off distance required for lift-off and for clearance of a 50-foot obstacle is presented as a function of aircraft gross weight at take-off power of 2800 rpm. The resultant speed at 50-foot altitude is 60 miles per hour, based on analyzer data, and rate of climb is 900 feet per minute. The distances shown thereon are for zero wind, standard sea level conditions.

Total landing distance required to clear a 50-foot obstacle and ground roll distances are presented as a function of engine rpm, over a gross weight range of 2000 to 2300 pounds at a wing incidence angle of 23 degrees. The approach speed at the 50-foot obstacle is 57 mph, based on analyzer data and the accompanying rate of descent is 900 feet per minute. The distances shown thereon are for zero wind, standard sea level conditions.

The distances determined from the Flight Analyzer data are correct. The camera timing indicator, and consequently speed, is believed to be in error by approximately 10%. Difficulty was experienced in regulating the voltage of the timer system on the analyzer. A higher voltage had to be applied for timer operation, thereby increasing the speed of the timing system. Comparison of these speeds with observed and recorded airspeed data show the speeds high by 10 per cent. Consequently, rates of climb and descent would also be in error, but in all cases, the numbers for each run are relative.

Figures 7 through 10 show typical Fairchild Analyzer photographs of take-off and landing obtained during test.

The best technique for maximum performance take-off and landing, as determined during the performance tests, is as follows: Maximum engine rpm with brakes held firmly; stick neutral during acceleration to 35 miles per hour indicated; brisk rotation at 35 miles per hour by pulling stick one-half to three-fourths back. As the aircraft rotates, air speed rapidly increases to 40 - 42 MPH indicated. With rapid additional airspeed, increase to about 50 as stick is returned to neutral. Aircraft then trims out to $F_e = 0$ climb speed of about 47 to 49 MPH indicated.

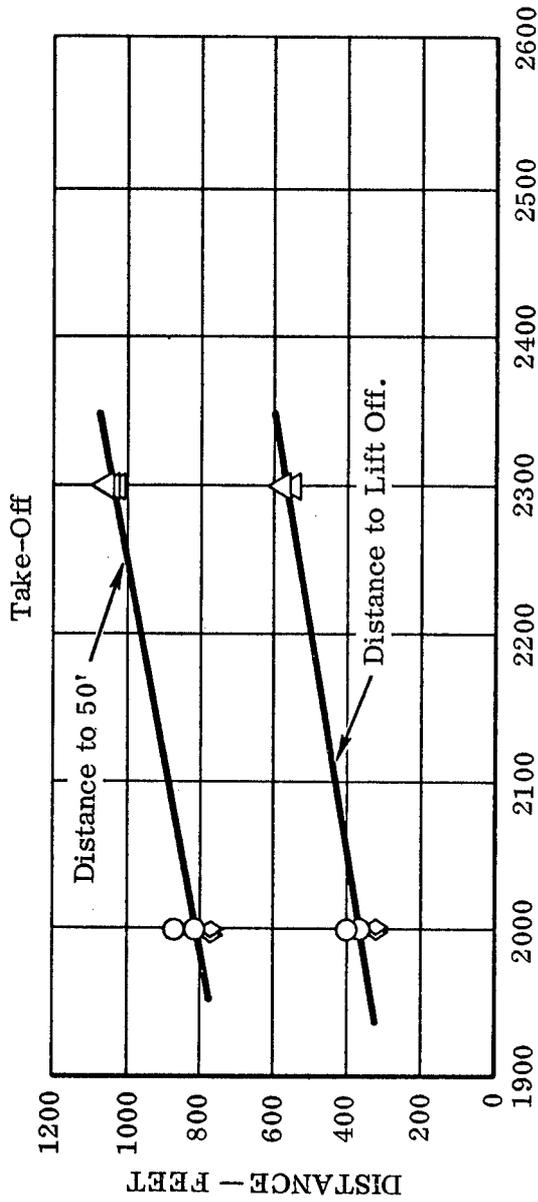
Landing approach is made at idle rpm which will produce a $F_e = 0$ airspeed of about 42 miles per hour indicated. Stick is eased full forward to gain 4 to 5 miles per hour airspeed at about 100 feet above the ground in order to provide enough elevator control power for flare. Full back stick is briskly applied just before ground contact at about 10 feet altitude. Average time from stick pull to touchdown is 3.5 seconds, with a high rate of attitude change and main gear only contact. Stick should be held back and full brakes applied. It is possible to scrape the ground with the elevator if the stick is not held back, especially if a complete stall with pitch-up is induced. After some practice, it is possible to stop in less than 30 feet using such a landing technique.

Table 3. Summary Take-off Data

Run No.	Gr. Wt. Lb	i_w Deg	γ 50' Deg	Σ_{Ft} S_H 50'	S_H Ft Gnd	S_H Ft Air	R/C 50' Ft/Sec	V_H 50' mph
38-1	2300	23°	8°	1050'	570'	480'	-	-
38-3	2300	23°	7.5°	1015'	550'	465'	15	60
38-5	2300	23°	7°	1040'	575'	465'	13	60
39-1	2000	23°	9°	870'	400'	470'	15	57
39-5	2000	23°	9°	815'	370'	445'	13	61
39-7	2000	24°	9.5°	770'	335'	435'	15	60
39-9	2000	24°	8°	770'	330'	440'	12	60

Table 4. Summary Landing Data

Run No.	Gr. Wt. Lb.	RPM	γ 50' Deg.	L/D 50'	ΣS_H 50 Ft.	S_H Air Ft.	S_H Gnd Ft.	R/S 50' Ft/Sec	V_H 50' Mph
38-2	2300	1500	11°	5.15	555'	340'	215'	16	58
38-4	2300	1400	12°	4.70	555'	295'	260'	11	58
38-6	2300	1300	10°	5.67	590'	325'	265'	14	56
39-2	2000	1600	10°	5.67	625'	385'	240'	15	58
39-4	2000	1500	10°	5.67	575'	355'	220'	13	53
39-6	2000	1400	11.5°	4.92	585'	320'	265'	16	57
39-8	2000	1300	12.5°	4.51	580'	320'	260'	14	58
39-10	2000	1100	12°	4.70	455'	290'	165'	16	55
39-12	2000	1000	14°	4.01	520'	330'	190'	17	57
39-14	2000	800	14°	4.01	350'	290'	60'	22	55
39-16	2000	800	13°	4.33	435'	275'	160'	16	55



GROSS WEIGHT

○ $i_w = 23^\circ$
 ○ $i_w = 24^\circ$

Landing

6w 2000 to 2300 LB $i_w = 23^\circ$

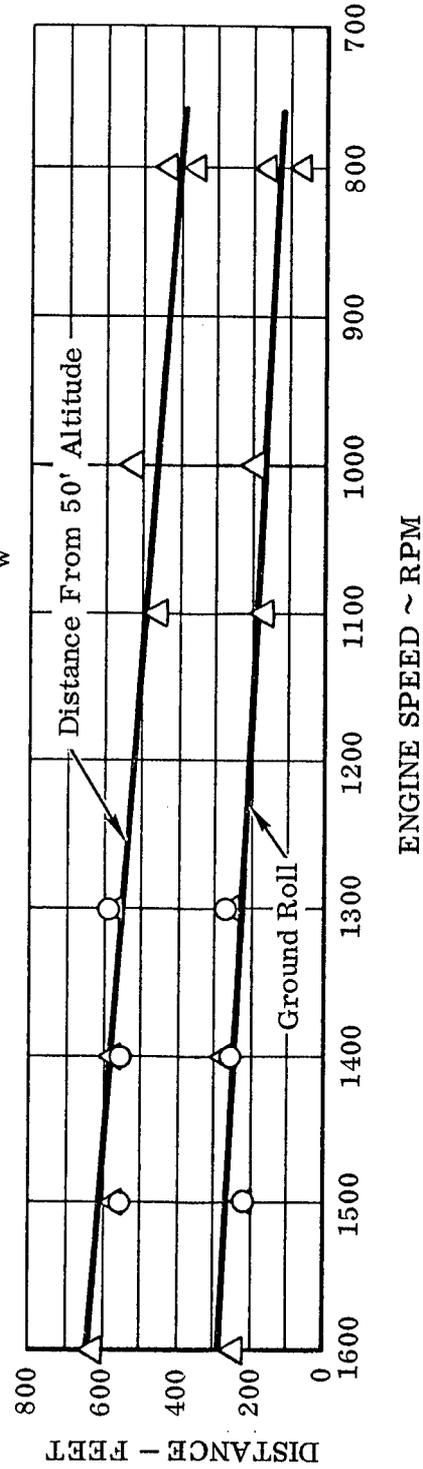


Figure 6. Take-Off and Landing Performance

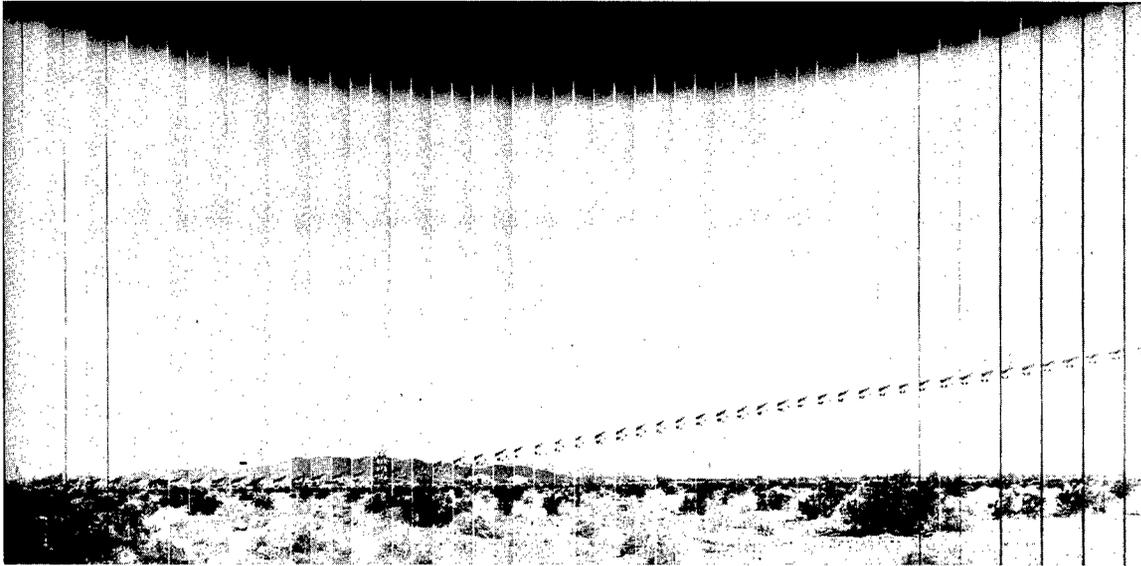


Figure 7. Take-off Flight Profile - 2000 Pounds Gross Weight

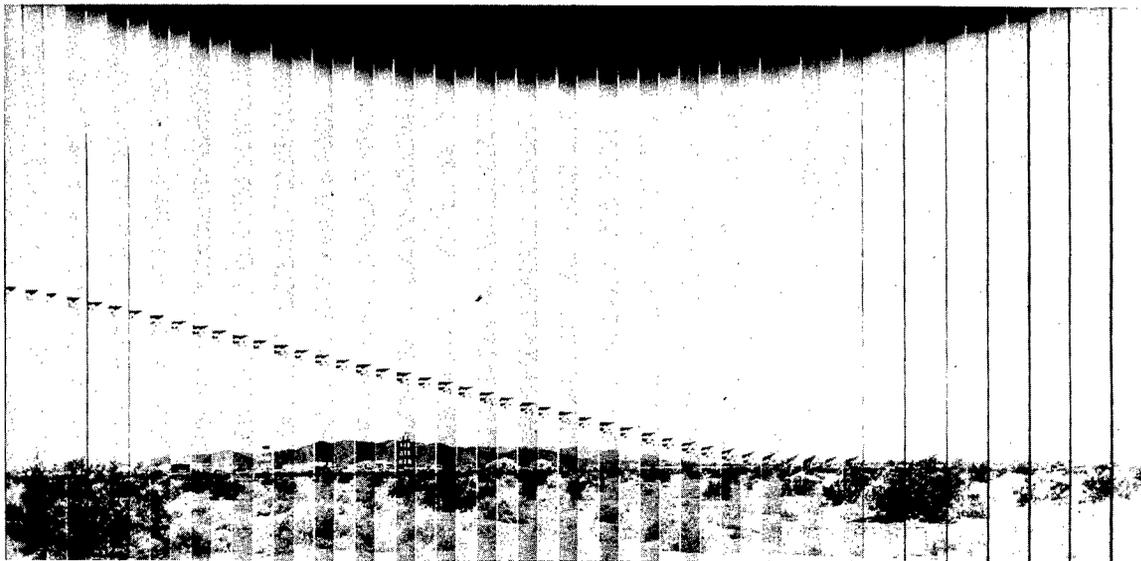


Figure 8. Landing Flight Profile - 2000 Pounds Gross Weight

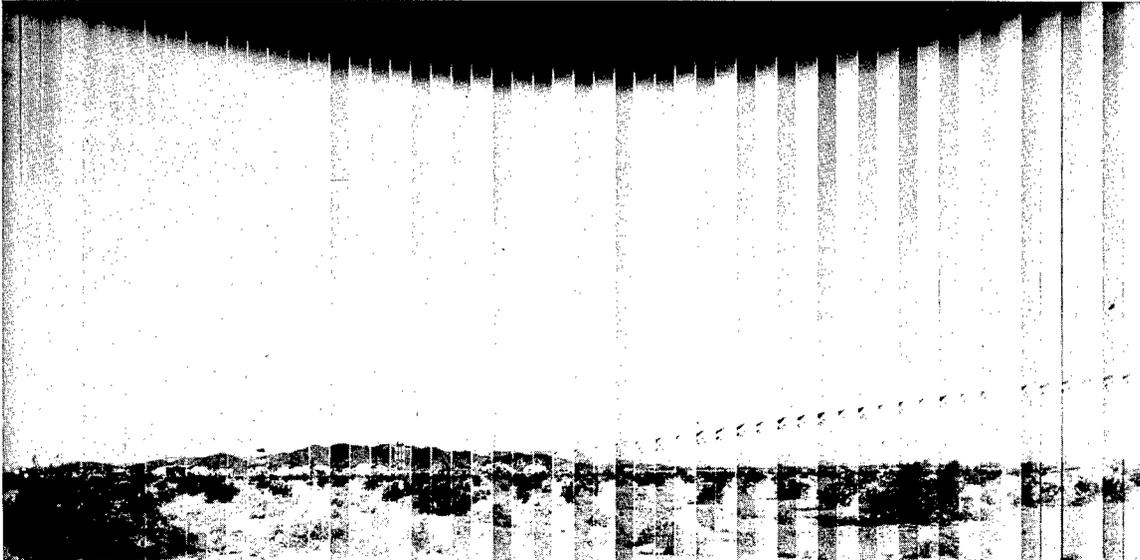


Figure 9. Take-off Flight Profile - 2300 Pound Gross Weight

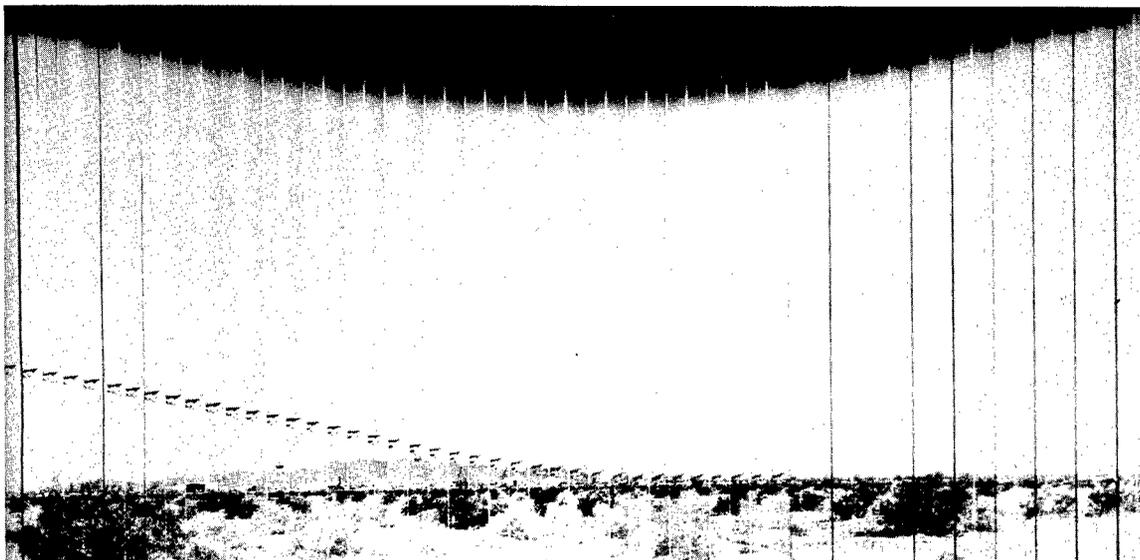


Figure 10. Landing Flight Profile - 2300 Pound Gross Weight

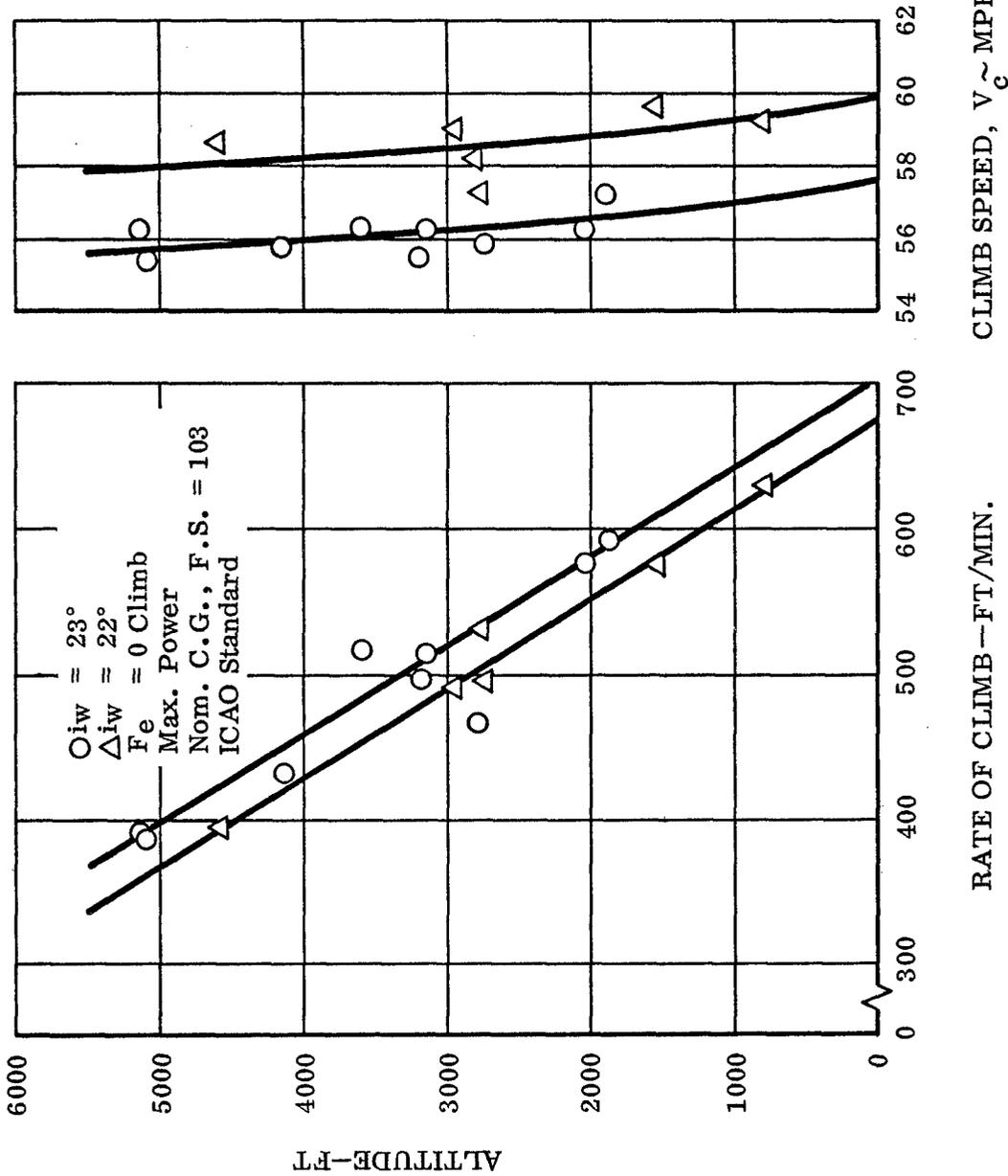
Climb Performance

Rate of climb data was obtained by making saw tooth climbs through a 1000-foot test altitude band. In addition, check climbs were made to verify climb schedules. The majority of climbs were made at the trim climb speed, zero stick force, for the wing incidence setting being tested.

Figures 11 and 12 show summary rate of climb data for 2000 pounds and 2300 pounds gross weight respectively. Rates of climb and the corresponding climb speed schedules are shown for both 22 and 23 degrees wing incidence settings. All test climbs were made at maximum power settings with the mixture set at full rich. As shown in Figures 11 and 12, a one to two mile per hour change in climb speed results in a 25 to 50-feet per minute change in rate-of-climb. At 2300 pounds, the sea level rate of climb exceeds the original estimate by 200 feet per minute.

A climb to maximum altitude was made at 2000 pounds take-off gross weight to determine service and absolute ceiling. The service ceiling, 100-foot per minute rate of climb, was 9350 feet density altitude. The absolute ceiling attained was 9900 feet density altitude. Time-to-climb to maximum altitude was 30 minutes and 12 seconds.

Gross Weight = 2000 LB



RATE OF CLIMB--FT/MIN.

CLIMB SPEED, V_c MPH

Figure 11. Rate of Climb Summary - 2000 Pound Gross Weight

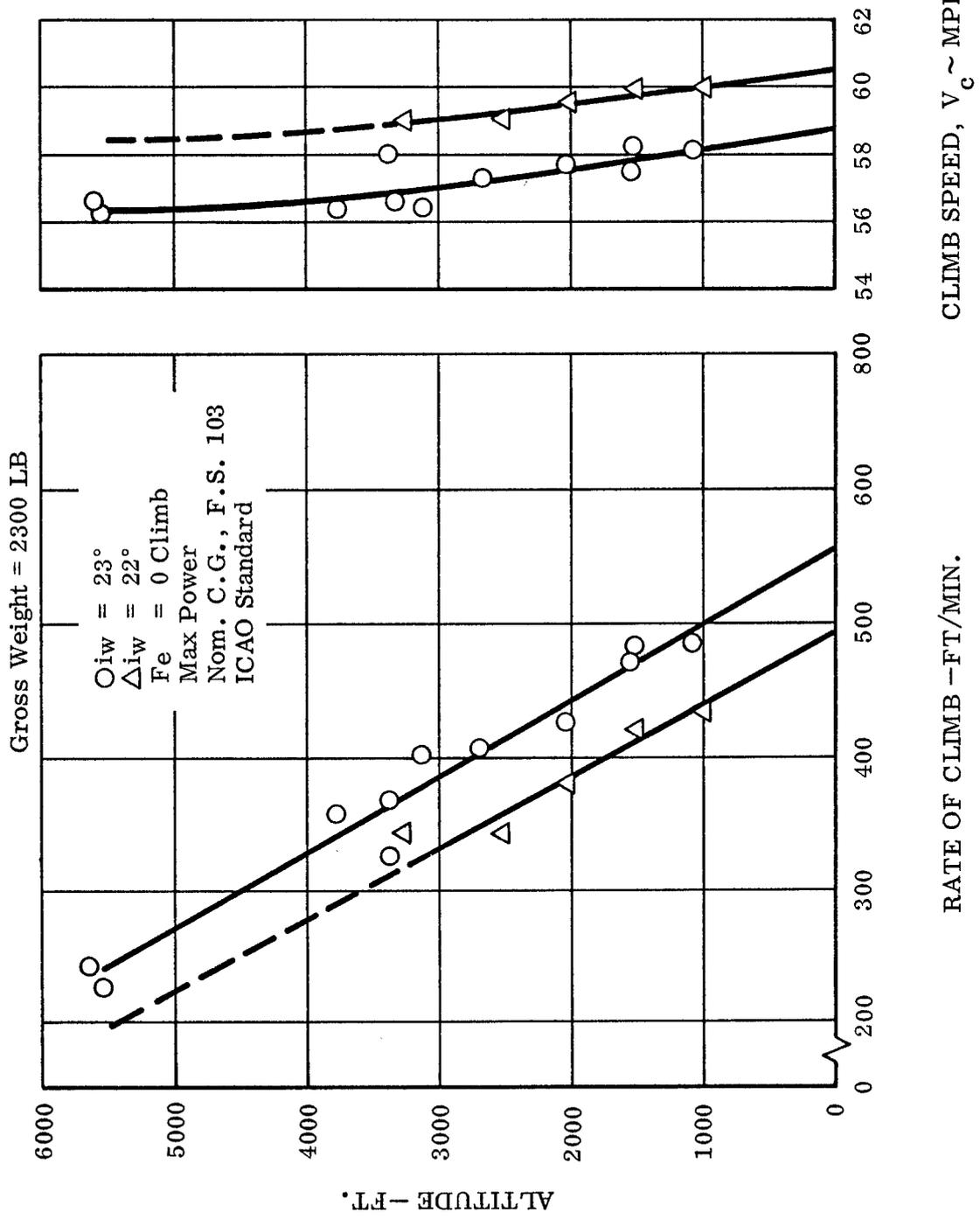


Figure 12. Rate of Climb Summary - 2300 Pound Gross Weight

Descent Performance

Considerable effort was expended in determining the descent characteristics of the aircraft. Throughout the course of the program, a wide variation in rates of descent were observed for the same test configuration, i. e. , weight, cg, wing incidence setting, and speed. Air turbulence is a major contributing factor to the variation in rate of descent. It is characteristic of this airplane to rock or roll laterally in turbulent air. This is due to the light wing loading and also a pendulum effect caused by the fuselage and center of gravity being well below the wing. The wing, when rolled, will spill some lift and thereby increase the rate of descent of the aircraft.

From the data obtained, the effects of speed, weight, wing incidence setting, and altitude produce minimum changes in rates of descent. The governing criteria for rate of descent is the rpm setting of the engine. Figure 13 shows rates of descents as a function of engine rpm.

The recommended descent procedure is to descend at the cruise wing incidence setting and adjust the rate of descent with power. The most comfortable and practicable descent is with power set at 1600-1700 rpm which is also the normal landing approach power setting.

○ iw = 23°
△ iw = 22°
Gross Weight = 2000 & 23000 LB

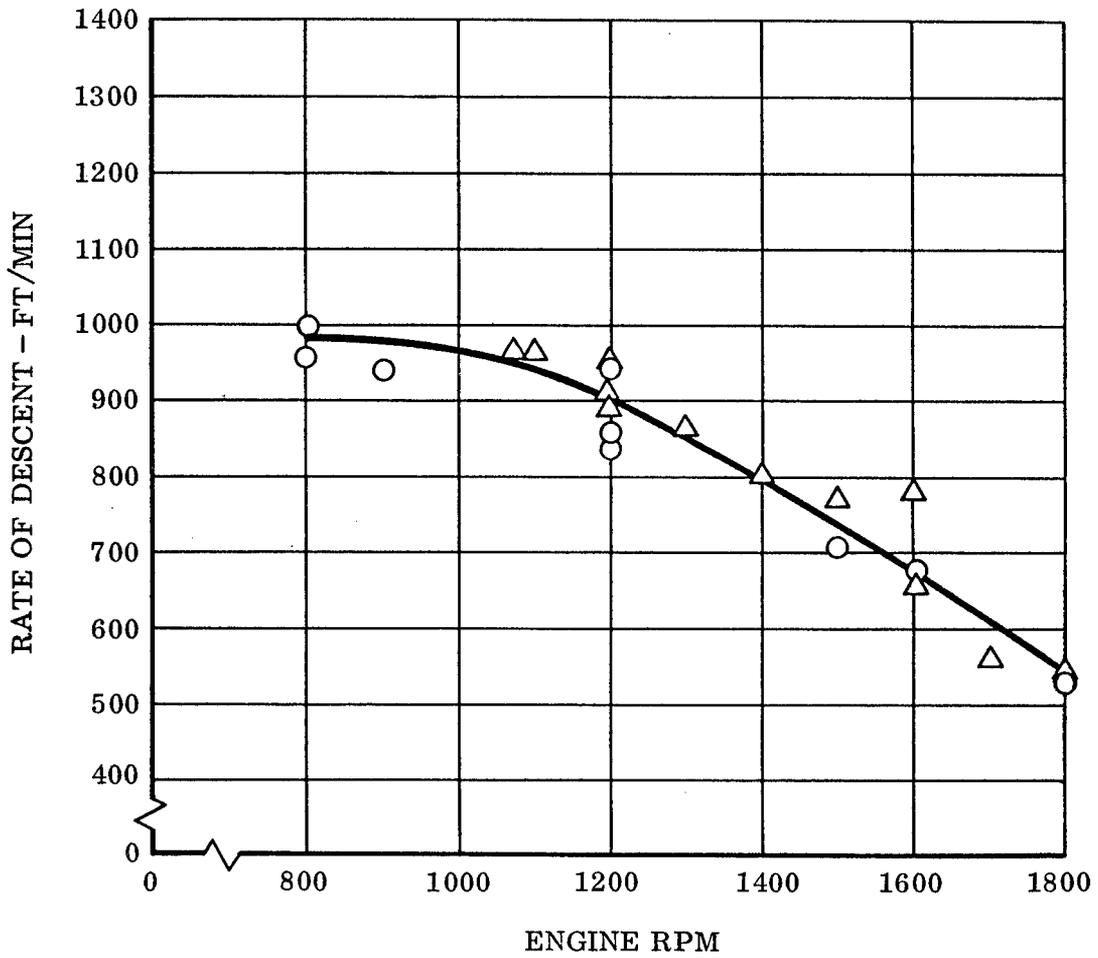


Figure 13. Average Rate of Descent vs. Engine RPM

Level Flight Performance

Level flight speed power data was taken at 3000 and 5000 feet pressure altitudes and at 2000 and 2300 pounds gross weight. A generalized power required curve as a function of velocity is presented in Figure 14. The associated generalized rpm vs. power required curve is presented in Figure 15.

All data is presented on an equivalent weight basis and reduced to sea-level standard day. To obtain data for altitudes other than sea level and weights other than standard, the following relationships must be used:

$$V = \frac{V_{ew}}{\sigma^{1/2}} \times \left(\frac{W}{W_s}\right)^{1/2}$$
$$BHP = \frac{BHP_{ew}}{\sigma^{1/2}} \times \left(\frac{W}{W_s}\right)^{3/2}$$
$$RPM = \frac{RPM_{ew}}{\sigma^{1/2}} \times \left(\frac{W}{W_s}\right)^{1/2}$$

Specific range data were obtained in conjunction with the speed power tests. Figures 16 and 17 show the specific range data for 3000 and 5000 feet respectively and in each case, data for 2000 and 2300 pounds is presented. The maximum endurance and 99 percent maximum range speeds are indicated on each curve. All testing was performed with the engine mixture set at full rich. These data show the aircraft capable of performing a 100-mile mission with maximum payload and cruising at 3000 feet.

Takeoff gross weight	2300 lb.
Total fuel	28 gal.
10 percent reserves	2.8 gal.
Useable fuel	25.2 gal.
Average R/C to 3000 feet	475 ft/min (Figure 12)

Average climb speed	58 mph (Fig. 12)
Time to climb	6.3 min.
Average climb fuel consumption	.375 gal. per min.
Climb fuel	2.36 gal.
Distance travelled in climb (zero wind)	6 miles
Descent fuel (assumed)	1 gal.
Distance travelled in descent	0
Fuel available for cruise	21.84 gal.
Average cruise specific range	4.65 mph (Fig. 16)
Cruise distance (zero wind)	102 miles
Total distance travelled	108 miles

Sea Level, Standard Day
Standard Weight = 2300 LB

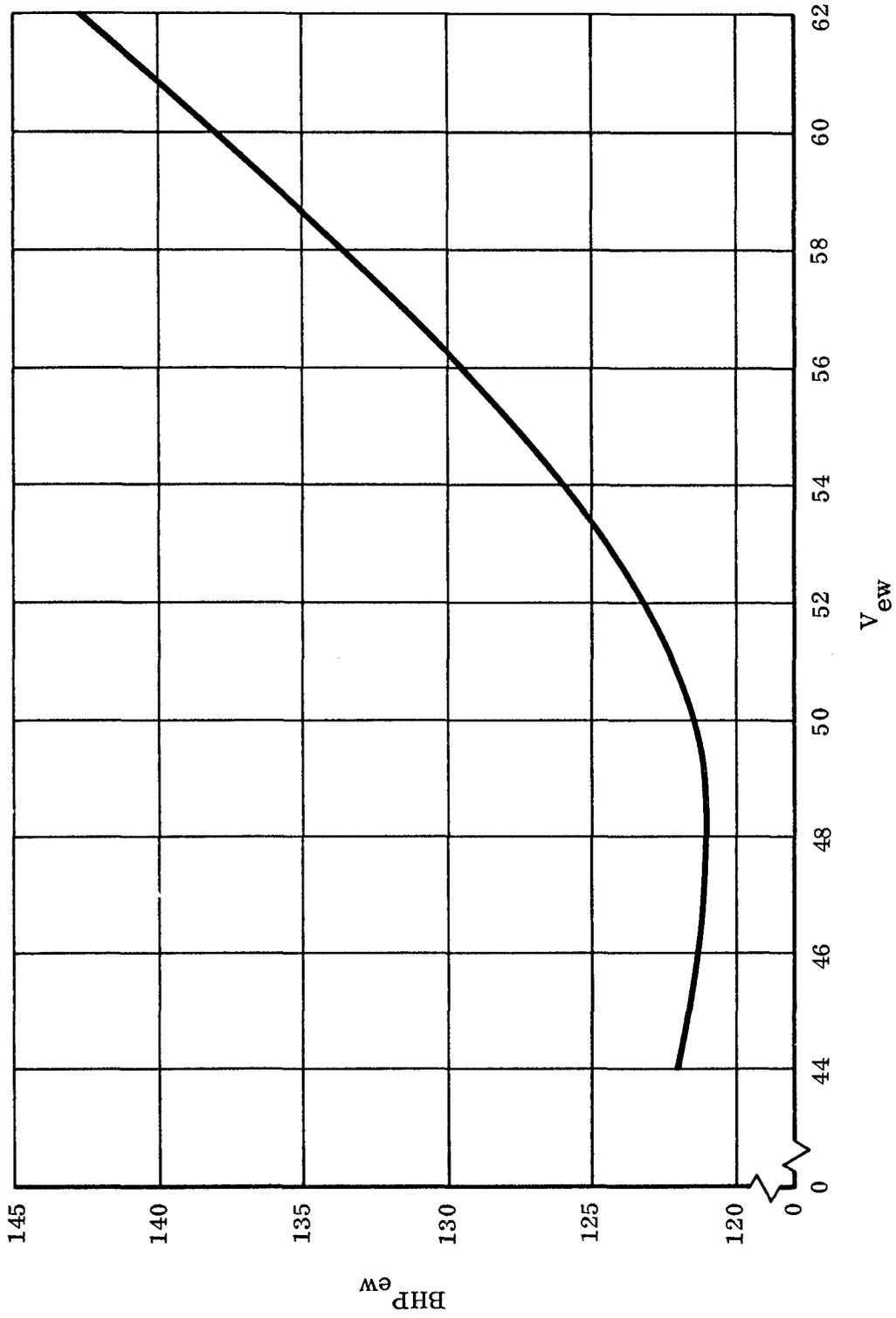


Figure 14. Generalized Power Required Curve

Sea Level Standard Day
Standard Weight = 2300 LB

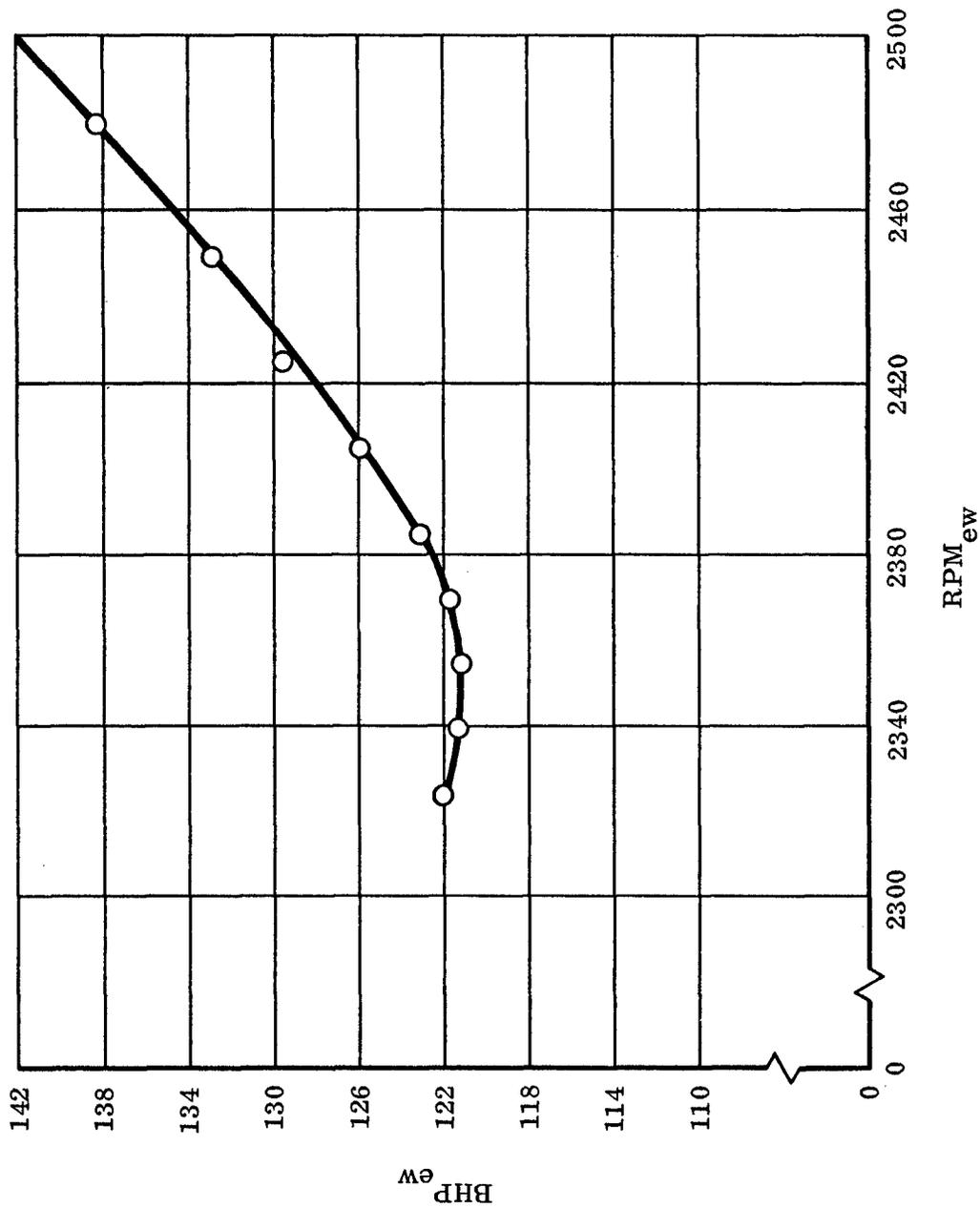


Figure 15. Generalized Engine RPM vs. Power Required

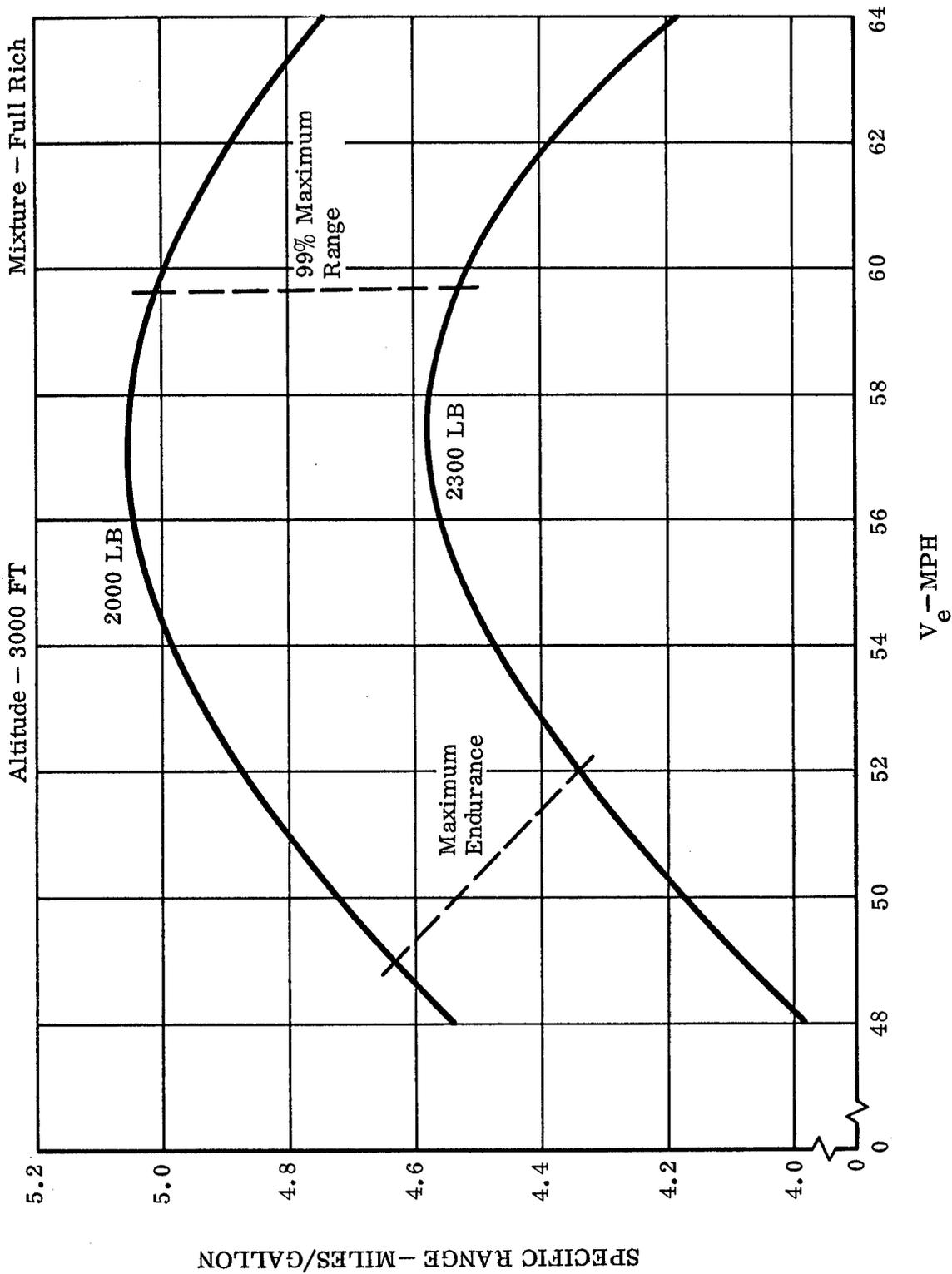


Figure 16. Specific Range vs. Airspeed - 3000 Ft. Altitude

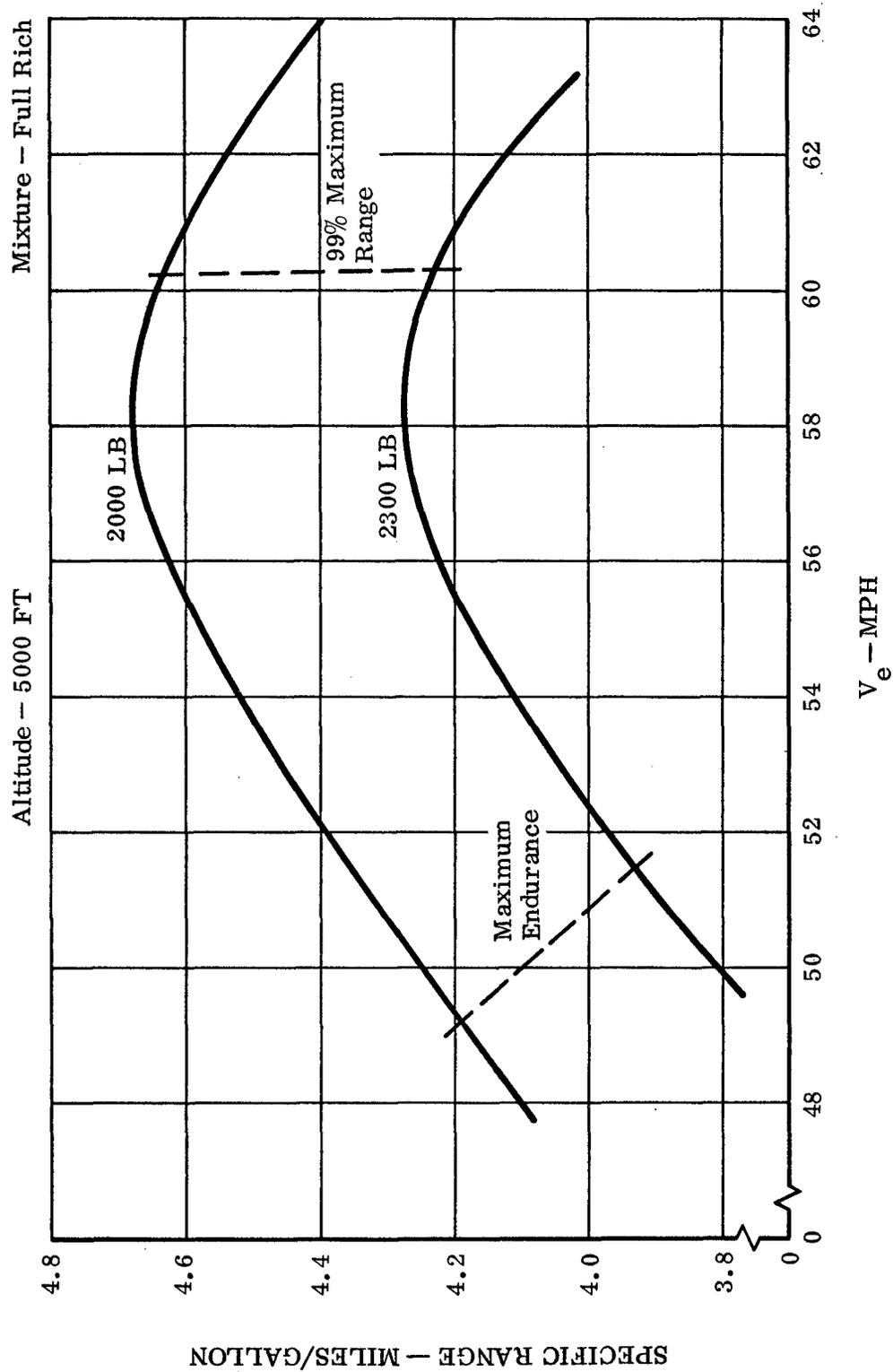


Figure 17. Specific Range vs. Airspeed - 5000 Ft. Altitude

Lift And Drag Characteristics

The lift and drag characteristics of the airplane as determined from test are presented in Figures 18 through 20. The lift and drag coefficients (Figure 18) were obtained from level flight speed power data. The data shows an improvement over estimated drag of the airplane. Figure 19 shows the associated L/D curve with the comparable improvement in maximum L/D. Lift-to-drag ratios obtained from two idle power glides recorded on the Fairchild Analyzer landing data show L/D's of 4.01 and 4.33. Figure 20 shows the lift coefficient as a function of wing angle of attack.

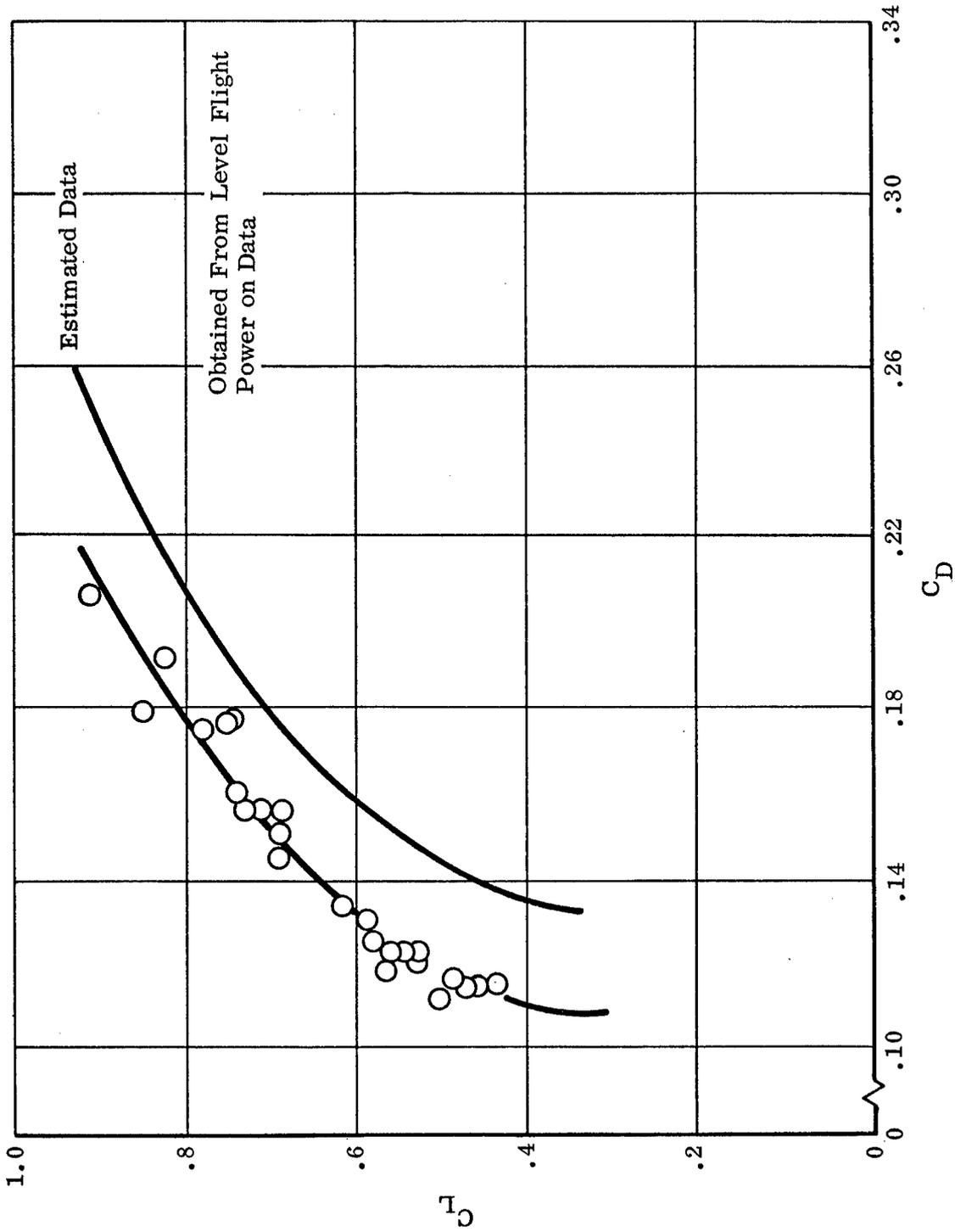


Figure 18. Lift Coefficient vs. Drag Coefficient

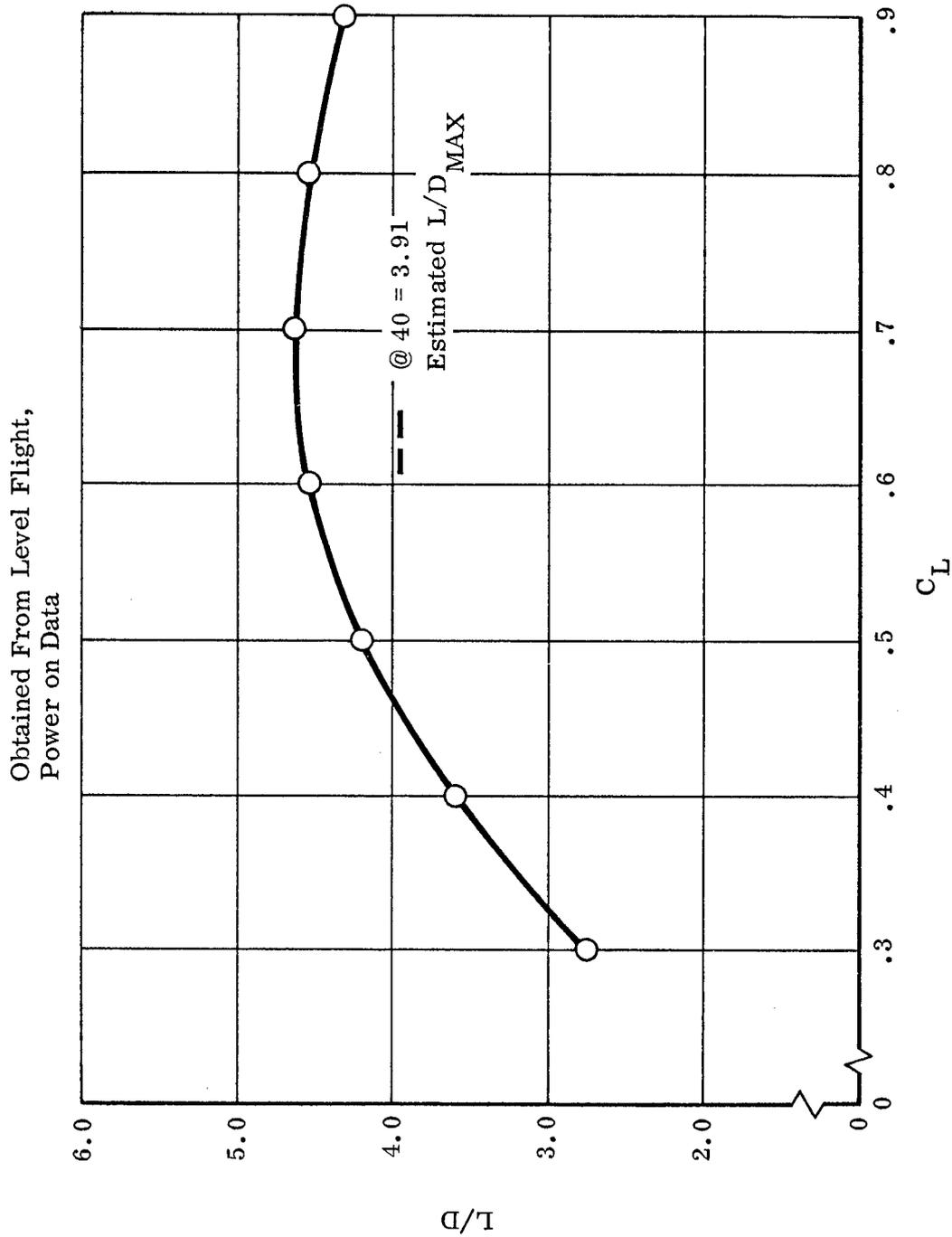


Figure 19. Lift to Drag Ratio vs. Lift Coefficient

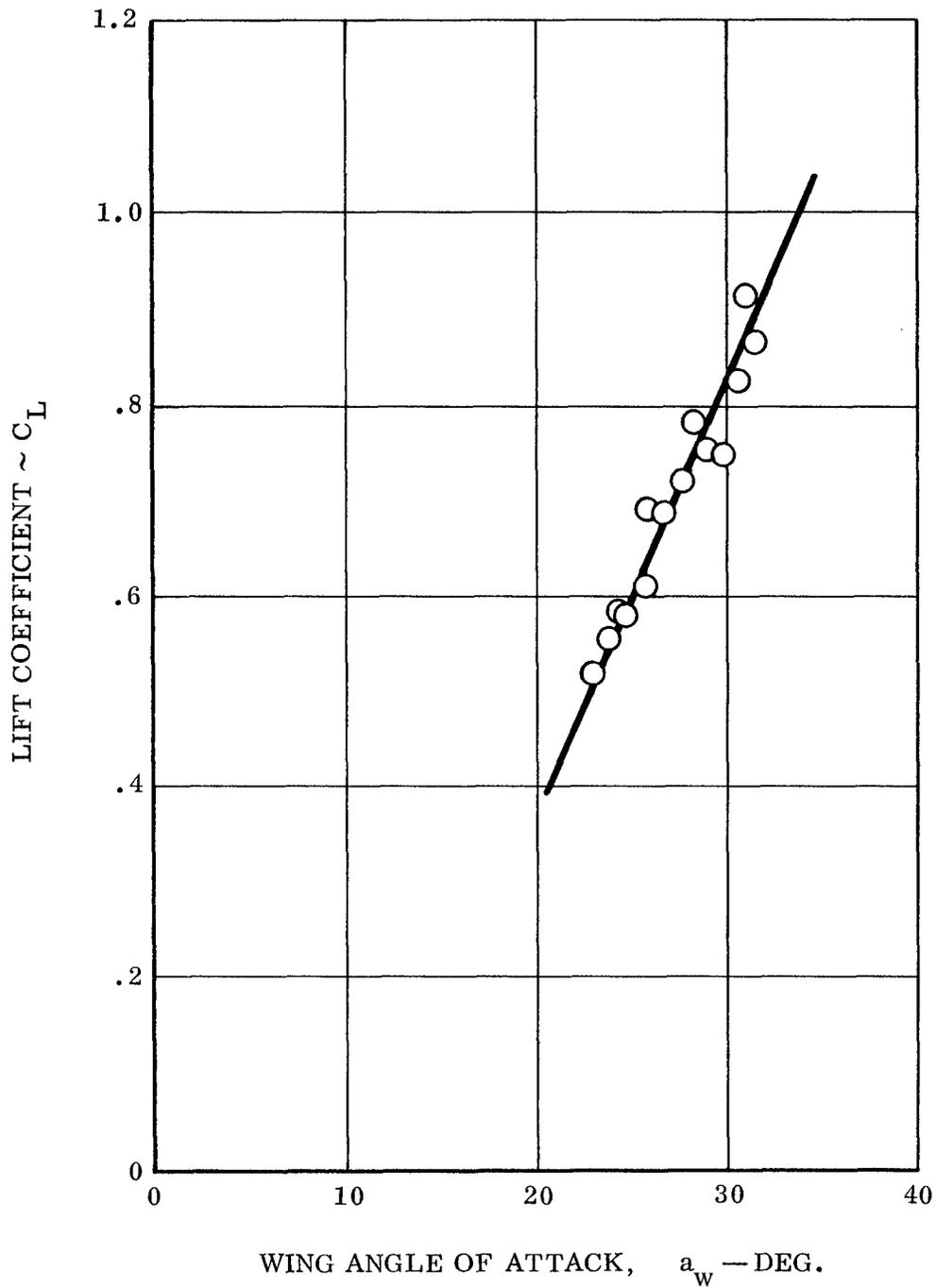


Figure 20. Lift Coefficient vs. Wing Angle of Attack

Operational Flight Envelope

The level flight speed envelope for 2300-pound gross weight at forward, nominal and aft center of gravity are shown on Figures 21 through 23. Figure 24 shows the envelope for 2000 pounds at nominal center of gravity. All data shown is for 3000 feet pressure altitude. The operational envelope is presented as a function of wing incidence setting, showing the maximum, trim, and minimum speeds attained at each setting.

The level flight V_{\max} limit is defined by full forward stick at speeds below 61 miles per hour. Between speeds of 61 to 62 miles per hour, a low frequency aileron oscillation is experienced. This oscillation is induced by a traveling wave in the wing fabric. This wave originates near the wing spreader bar and moves aft. As each wave reaches the trailing edge of the wing, the flapping action is transmitted to the ailerons which in turn feed through the control system to the pilot's control wheel. This characteristic is present only at high speed when the wave frequency approaches two to three cycles per second. This phenomena starts as a random pulse at the control wheel and as speed is increased, it builds up to a steady beat. In all cases, it has been readily discernible by the pilot. This characteristic does not present a serious operational limit to the aircraft. Trim speeds or normal operating speeds are well below V_{\max} . Consequently, this oscillation will not be experienced unless a deliberate attempt is made to reach these speeds.

Handling qualities at low speeds ($V_{\text{stall}} + \text{two mph}$) are normal and not much different than cruise performance except for the large aft stick displacements and forces. Stalls are difficult to obtain in level flight at nominal and impossible to obtain at forward cg; therefore, V_{\min} under these conditions, is defined by full aft stick. Low wing loading prevents any significant g force buildup even in maximum pilot effort turns which minimizes the possibility of accelerated stalls. Level flight stalls at nominal to aft cg are difficult to obtain and are preceded by good stall warning indications. At higher power settings, torque effect causes right yaw followed by pitch-up resulting in a rolling turn to the right which is easily arrested by forward stick, opposite wheel and power as required. At reduced rpm, the stall warning consists of a rapid decay of high pull force with pitch-up which is easily arrested by nosing over and power as required. If aft stick position is held constant through a complete stall, the aircraft will assume a steep descent angle until air speed build-up increases elevator effectiveness for recovery.

Due to the narrow speed range available, it is practical to set the longitudinal trim prior to takeoff for the entire flight. A curve of the optimum wing incidence setting versus cg locations is presented in Figure 25.

Gross Weight = 2300 LB
Fwd. C.G., F.S. 98.5
Altitude 3000 Feet

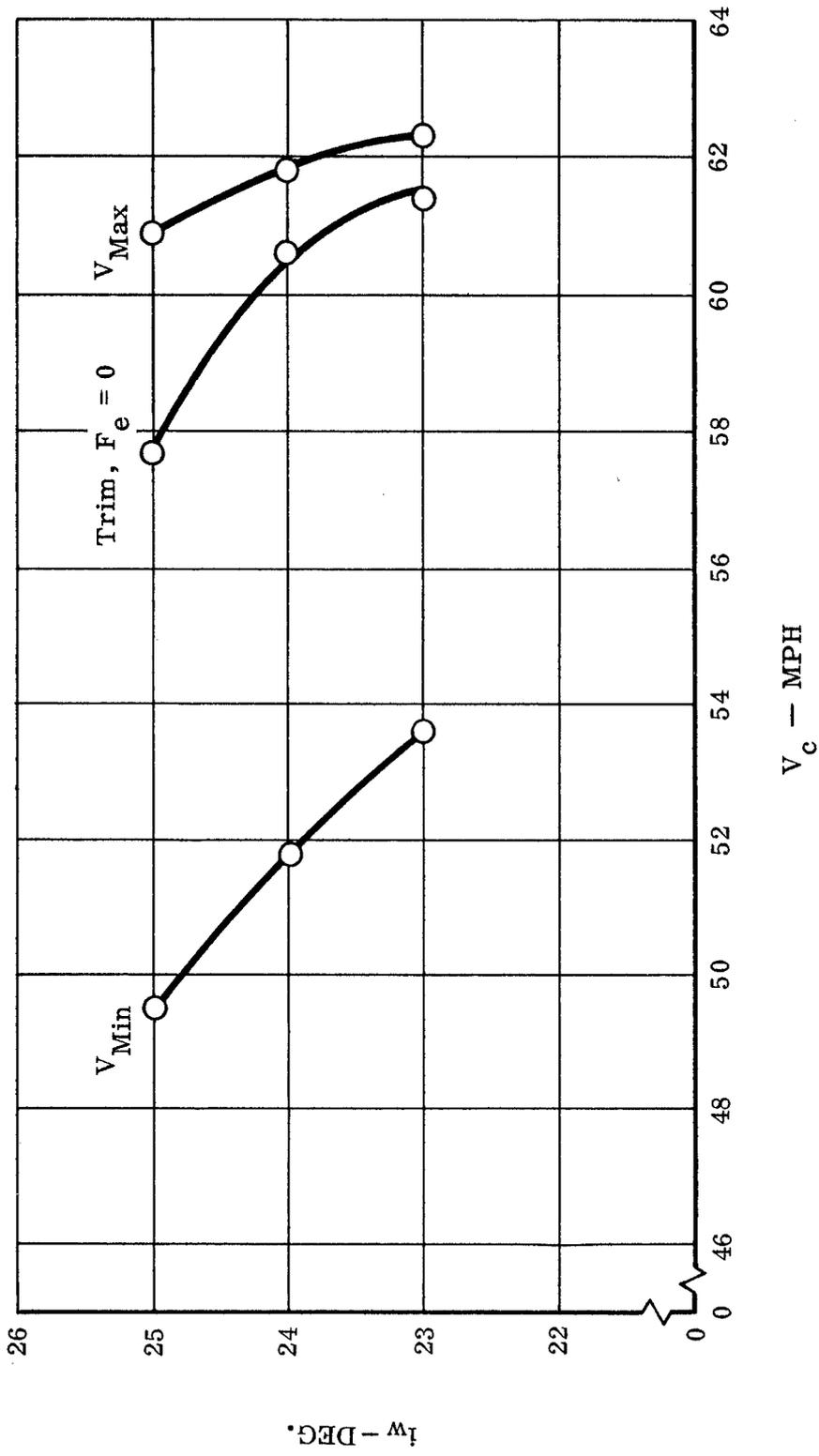


Figure 21. Level Flight Speed Envelope - Fwd CG 2300 lb.

Gross Weight = 2300 LB
 Nom. C.G., F.S. 103
 Altitude 3000 Feet

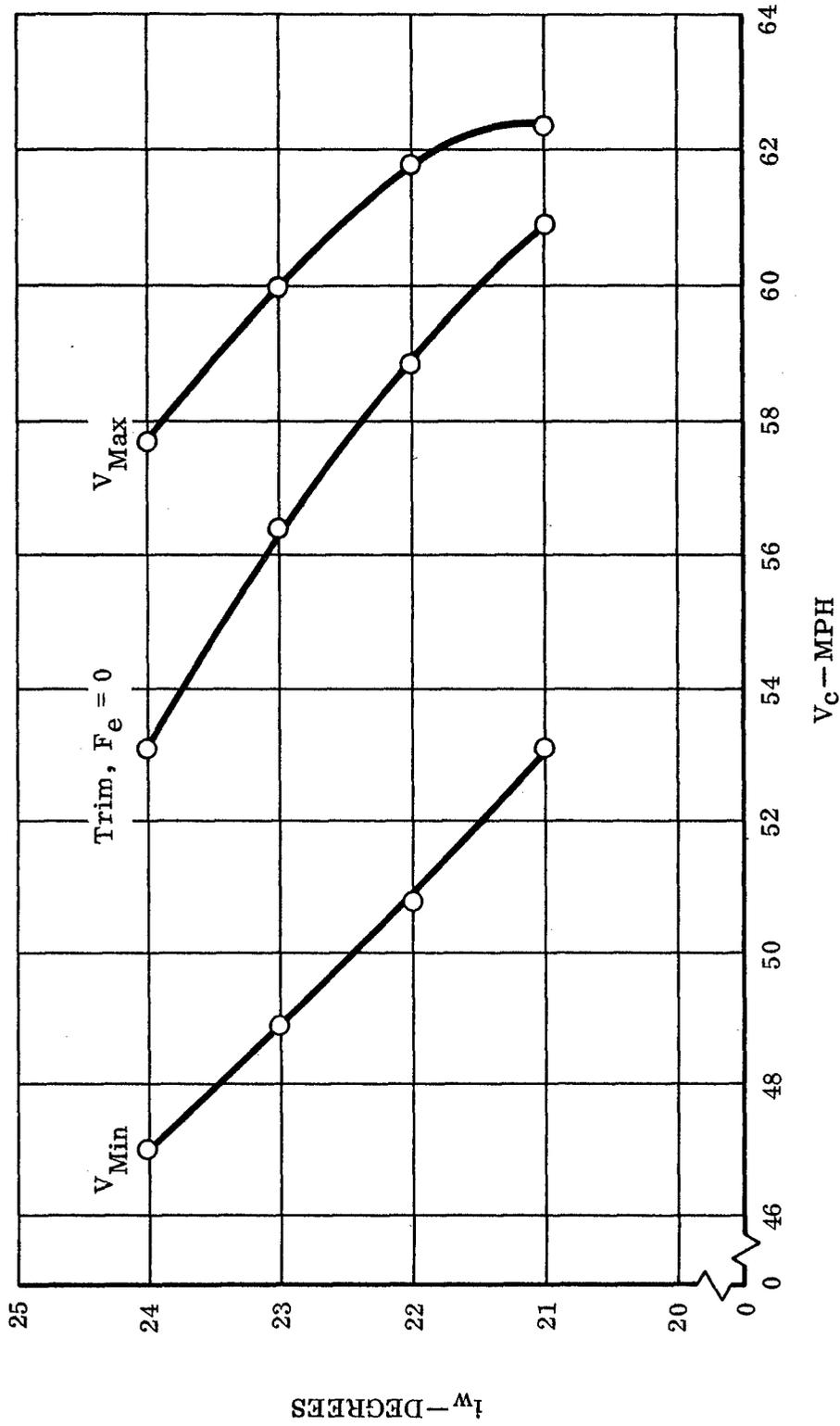


Figure 22. Level Flight Speed Envelope - MID CG 2300 lb.

Gross Weight = 2300 LB
 AFT C.G., F.S. 106
 Altitude 3000 Feet

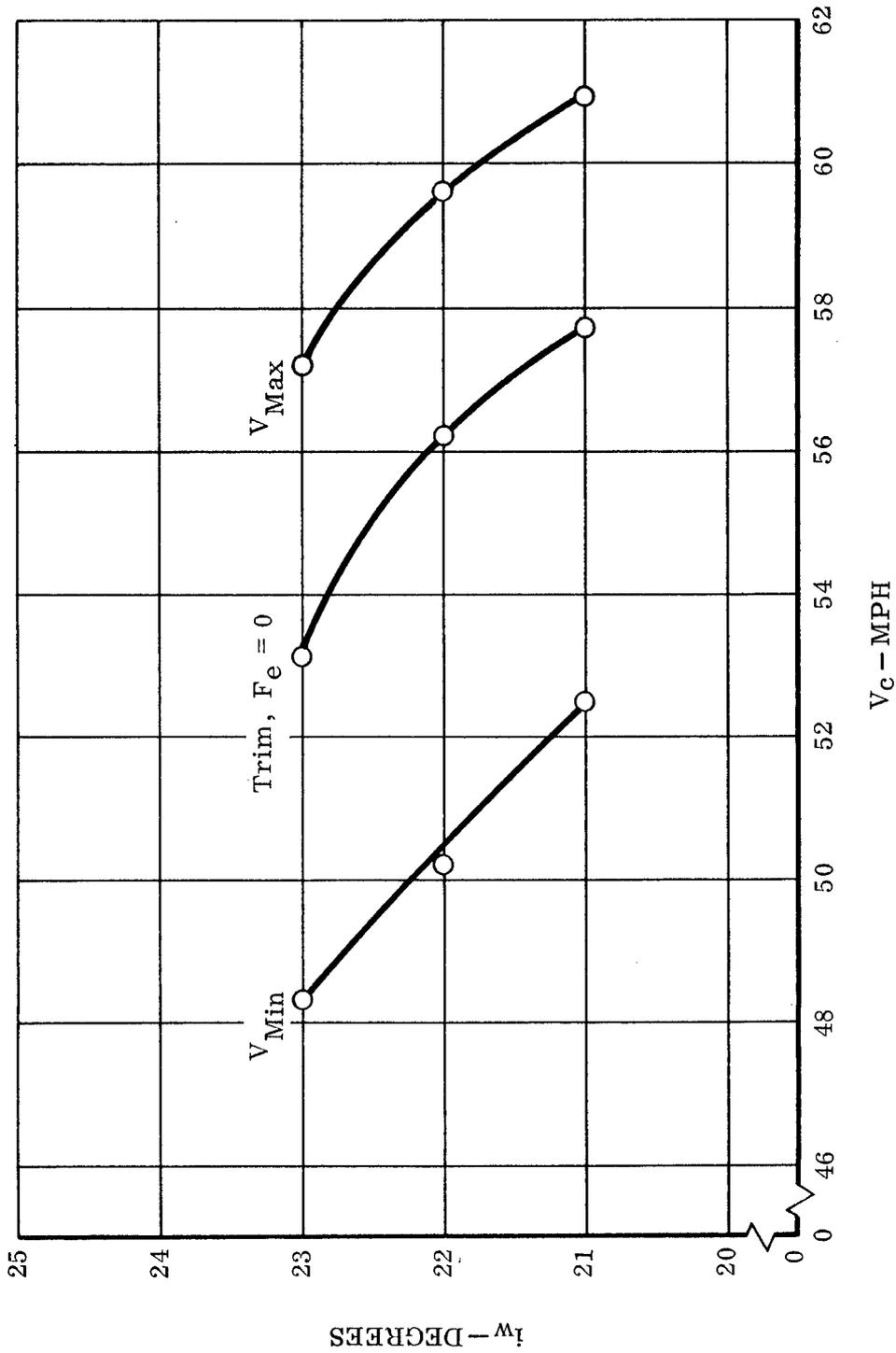


Figure 23. Level Flight Speed Envelope - Aft CG 2300 lb.

Gross Weight = 2,000 Lb.
 Nom. C.G., F.S. 103
 Altitude 3000 Feet

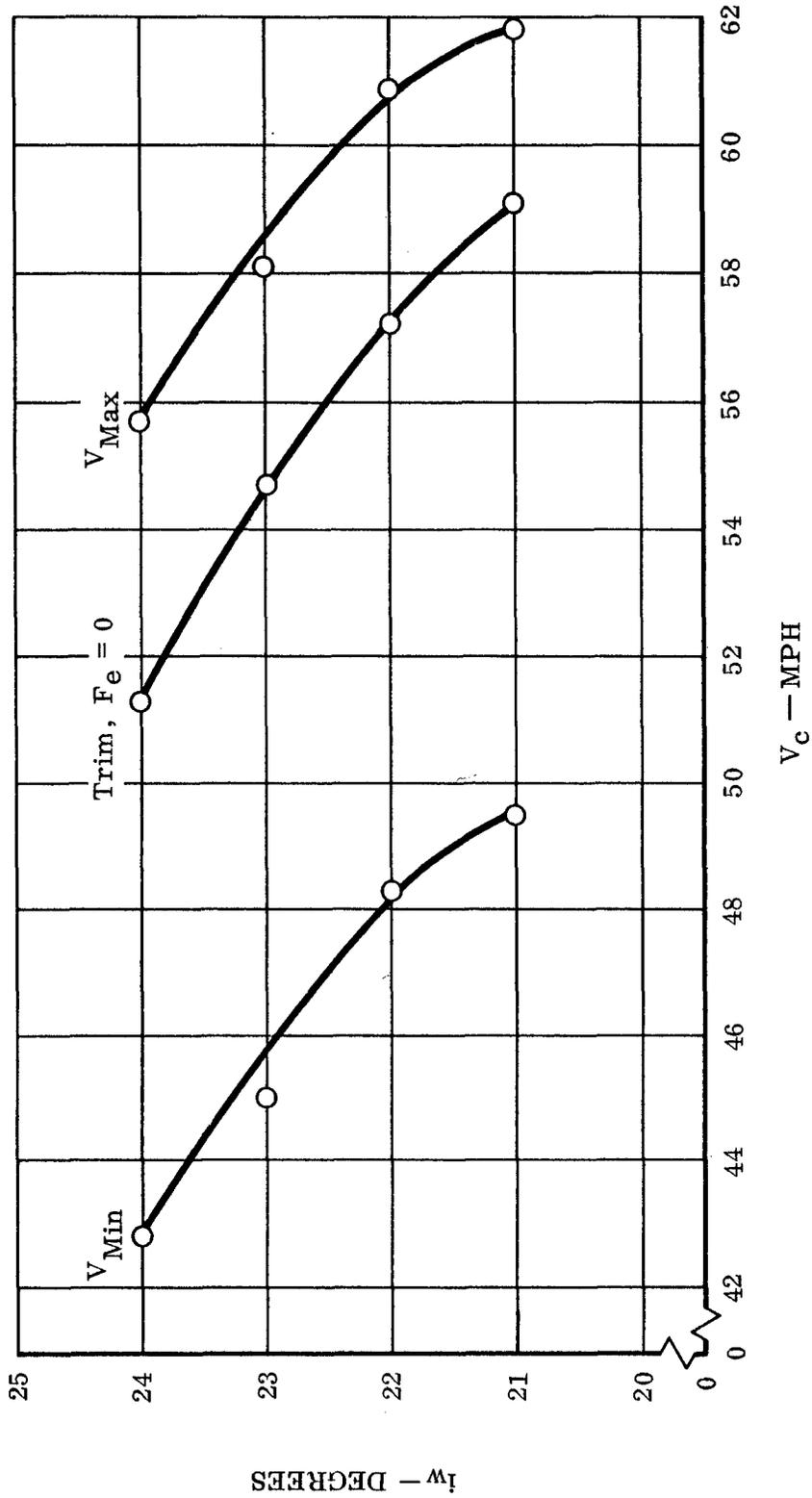


Figure 24. Level Flight Speed Envelope - Nom CG 2000 lb.

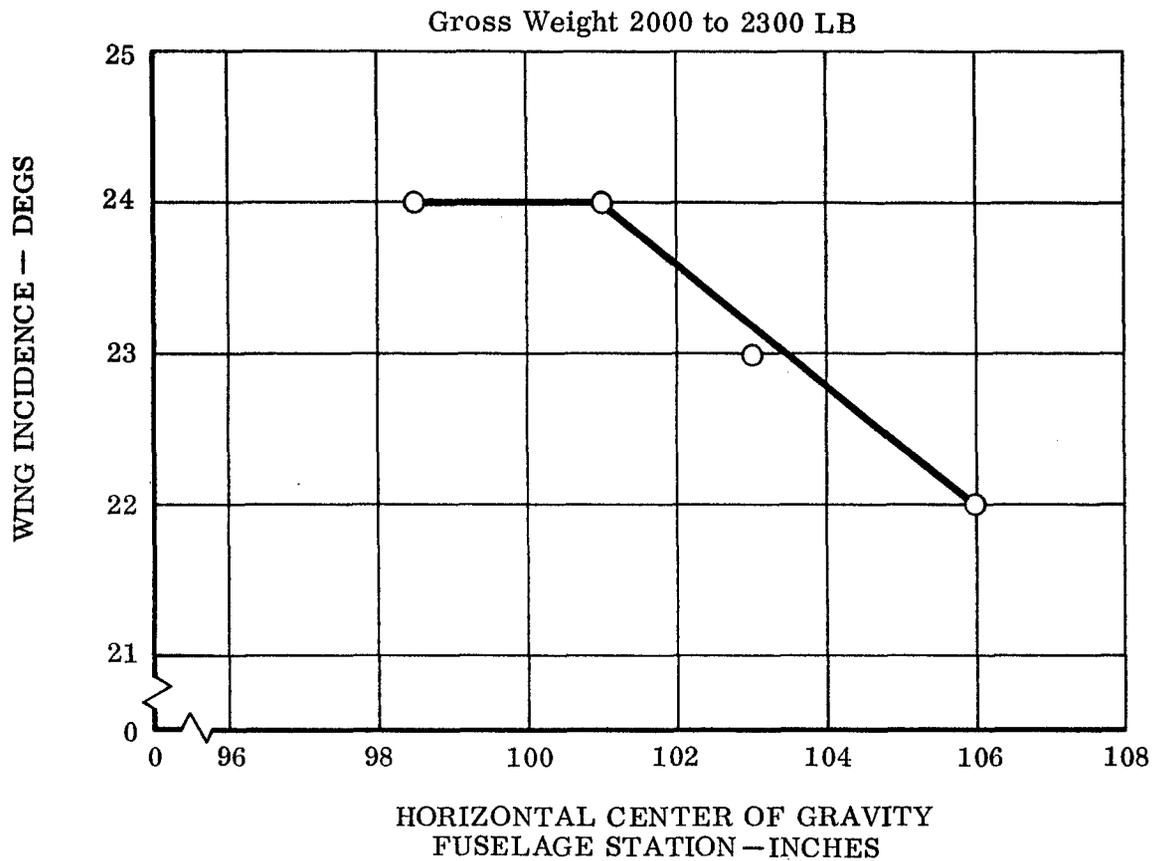


Figure 25. Operational Wing Incidence Setting vs. Horizontal CG Position

Center of Gravity Limits

A total of 7.5 inches of horizontal cg travel has been established as allowable limits for the airplane. The forward cg limit is at Fuselage Station 98.5 and the aft limit at Fuselage Station 106.0. Nominal cg was considered to be at Fuselage Station 103.0. The maximum forward and aft cg limits were the maximum attainable with the aircraft configuration under test. These limits were dictated by the position of the instrumentation pallet located on the cargo platform. For this reason, the limits as defined here are not to be taken as absolute limits defined by marginal control or safety of flight.

No limits were established for vertical center of gravity travel. Throughout the test program, the vertical cg was maintained between water lines 35.0 and 36.0.

Propeller Blockage

Two flights were made with simulated cargo loads set at various heights above the cargo platform to determine any possible effects on performance and handling qualities. The first simulated cargo load tested, Figure 26, was a box measuring 57 x 65 x 21.5 inches set toward the rear end of the platform. The width of the load was equal to the width of the platform and the height represented a distance equal to half the distance from the platform to the engine thrust line. The second configuration, Figure 27, consisted of an additional box measuring 57 x 32.5 x 17 inches set sideways on the lower box. This brought the cargo height to within five inches of the thrust line. Both flights were made at maximum gross weight and nominal cg .

General handling qualities on both flights were favorable throughout all flight regimes. No noticeable changes in forces, control response, and maneuverability could be detected.

A change in airplane performance was observed as a result of propeller blockage. Figure 28 shows the change in the power required curve for the two configurations tested. The same trim, maximum and minimum speeds were attained, ; however, more power was required in each case.

A rate of climb and rate of descent performance check was also made for each configuration. Figures 29 and 30 show the effect of climb and descent performance respectively. A decrease in rate of climb performance of 150 foot per minute is experienced with maximum propeller blockage. A corresponding 150 foot per minute increase in rate of descent is obtained for the same configuration. This degradation in climb and descent performance is commensurate with the increased power required to obtain the same speed at cruise, thus indicating increased drag and/or decreased propeller efficiencies.

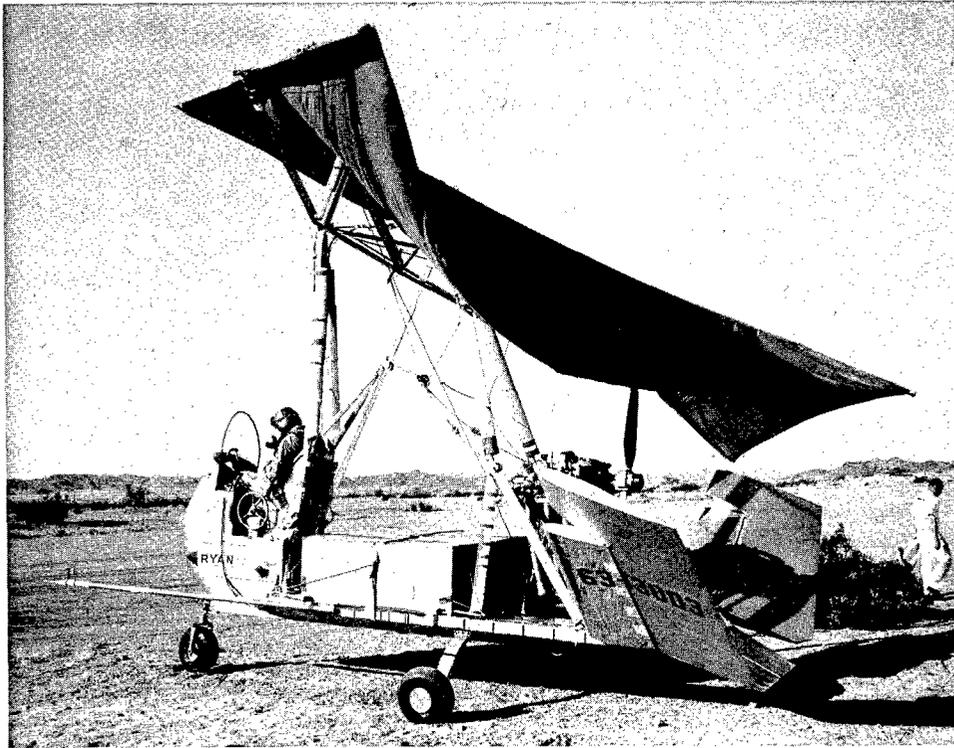


Figure 26. Medium Height Propeller Blockage Configuration

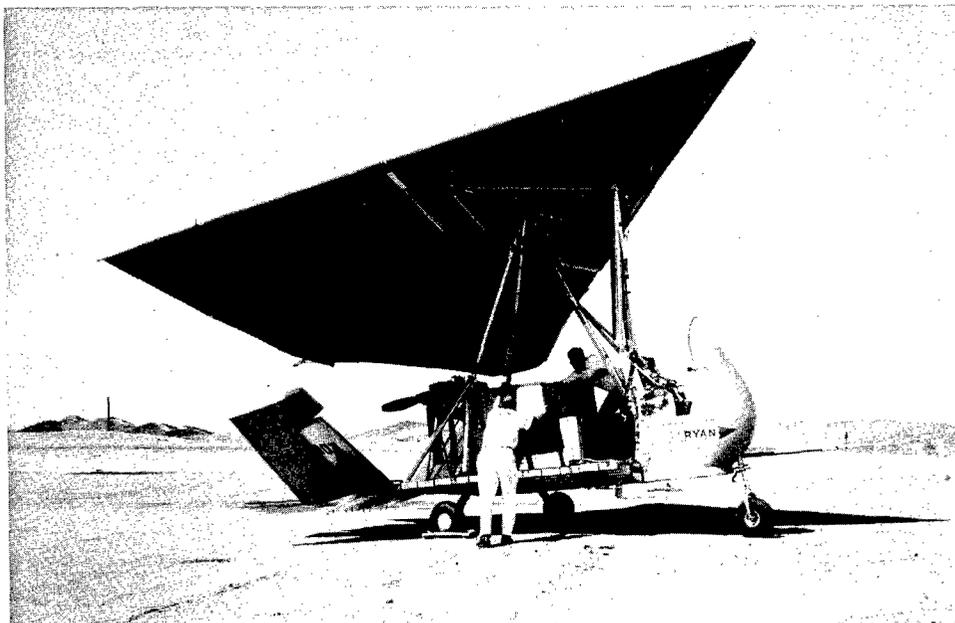


Figure 27. Maximum Height Propeller Blockage Configuration

Cruise Power Required.

Sea Level - Standard Day
 Standard Weight = 2300 LB
 Nominal C.G., F.S. 103.0
 $i_w = 23^\circ$

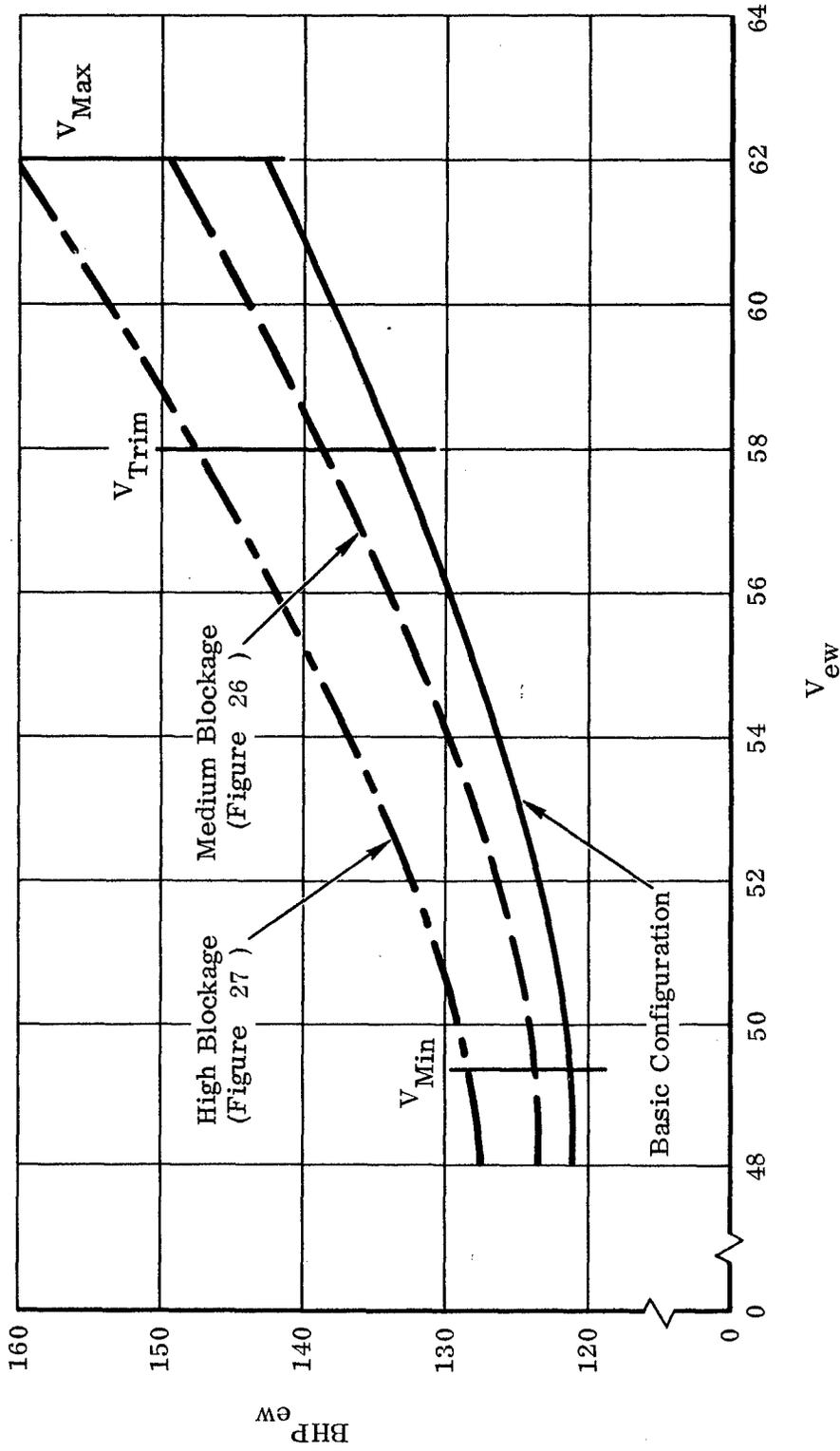


Figure 28. Effect of Propeller Blockage on Cruise Power Required

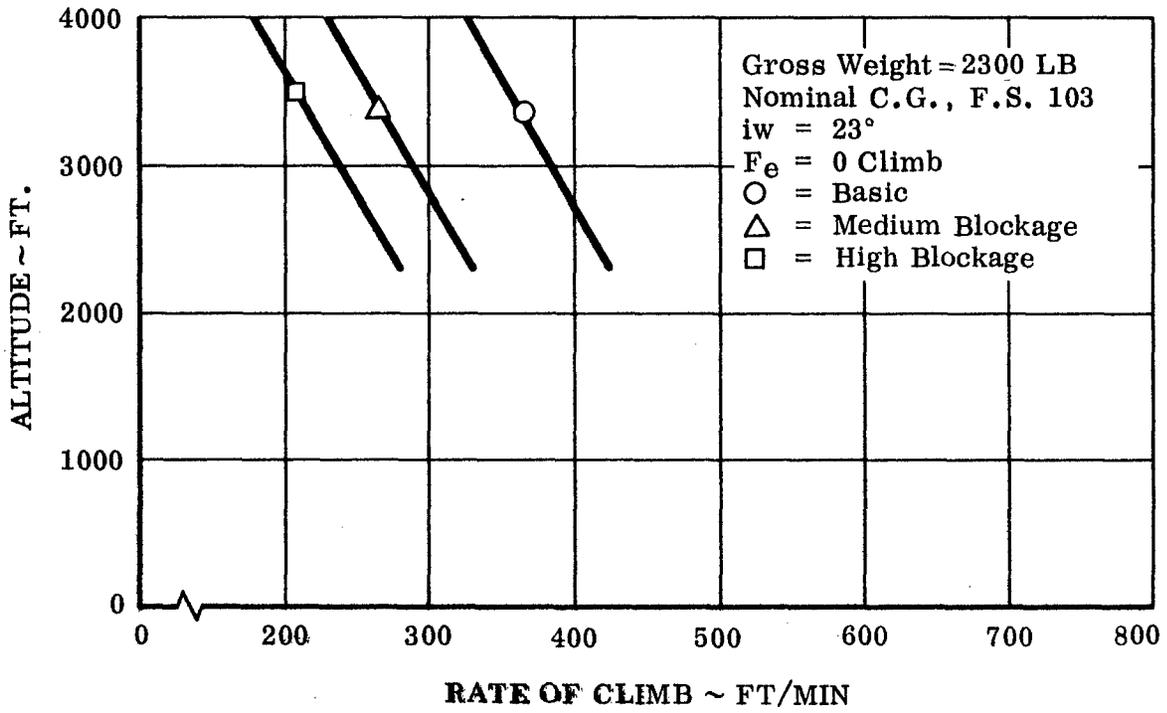


Figure 29. Propeller Blockage Effect on Rate of Climb

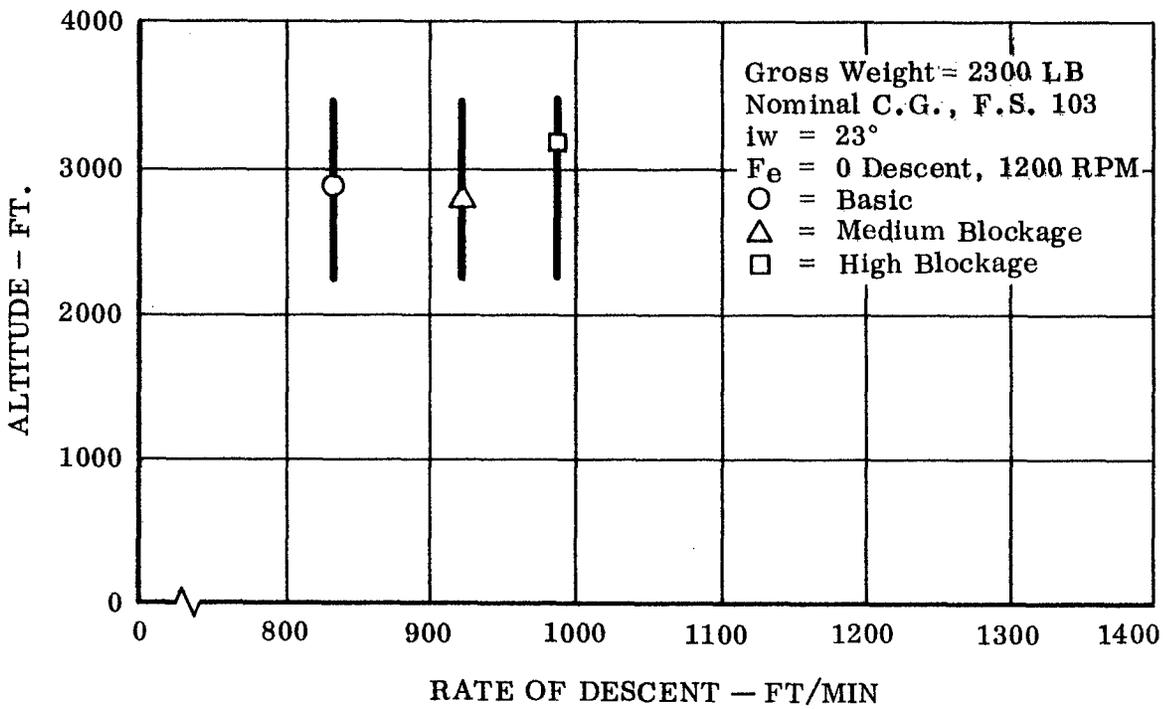


Figure 30. Propeller Blockage Effect on Rate of Descent

Cross Wind Capability

Experience to date shows that the aircraft can be landed easily in ground distances of 25 to 50 feet, which reduces the cross wind operational question primarily to taxi and take-off. Because of the low approach speeds, rugged landing gear and gear geometry, it is felt that a suitable area can always be found for an approach generally into the wind such as taxiways, across a normal runway, helicopter pads, reasonably flat open fields or desert, etc. Using the two-control system landings in winds up to 5 knots, 90 degrees across and 10-15 knots, 20-30 degrees across are feasible. Best cross wind landing technique is to accept the crab angle and drift with resulting side loads on touchdown, using immediate directional correction by nose wheel steering, which is very effective. Corrections can be made for drift, using roll control down to the flare point, but such corrections cannot be held without a separate directional control system.

Taxi operations are feasible in winds of 20 knots and possibly higher at reasonably slow speeds. During cross wind taxi, the upwind wing will tilt up, full deflection, and the pilot will have no lateral control authority until a ground speed of about 25-30 mile per hour is reached (when q forces provide enough lateral control power for wing control).

Since takeoff ground rolls average 200 to 400 feet, depending on gross weight and wind, a safe useable technique was evolved for cross wind take-offs varying from 15 knots from 35-40 degrees, to 10 knots from 90 degrees. Maximum power is applied with brakes, followed by roll with wing tilted until about 25 mile per hour, when the wing can be rolled down into the wind. The aircraft is lifted off the ground at 40 mile per hour, and roll control is used to correct heading if necessary for climb.

Rough Terrain Operation

Three test operations were conducted from an unprepared desert surface. Several take-offs and landings were made with observed ground roll distances very similar to those attained on hard surfaced runways. No operational difficulties were encountered during any of these test operations.

These operations proved the structural integrity of the main gear Fiberglass strut system. Sufficient flexibility is in the strut system to absorb high landing impact loads and bump loads encountered on unprepared surfaces.

One explicit advantage realized from these operations is that the take-off and landing runway becomes omni-directional, thereby eliminating any concern for cross-wind.

Loads

A complete static structural test program was made on the aircraft prior to initiating the flight test program. At this time, all structural members were tested to the design load limit and in all cases were found to be satisfactory.

During the flight test program, key structural members on the aircraft were fitted with strain gages to permit monitoring of the loads received in flight. At no time during the test program were any of the loads observed to be beyond limits. Table 5 following includes the observed and allowable loads for the structural members monitored.

Table 5. Summary Loads Data

	<u>Function</u>	<u>Allowable</u>	<u>Actual</u>
T*	Keel @ Apex	33,000 psi	1800
T	Center Strut	42,000	900
C/T	Spreader Bar (top left)	5573/40000	5000/700
C/T	Spreader Bar (diag. left)	5573/40000	1400/15000
C/T	Fwd "V" (left)	14050/20200	1700/2000
C/T	Fwd "V" (right)	14050/20200	2200/1500
C/T	Aft "V" (left)	10500/10500	1500/1700
C/T	Aft "V" (right)	10500/10500	1000/3400
	Load Pitch Cable	3700 Lb.	150 Lb.

*T = tension

c = compression

Aircraft Maintenance and Serviceability

Virtually maintenance-free operation was experienced throughout the entire testing period. A 100 percent in-commission rate was achieved for a program time of 46 engine hours, 36 of which were flight hours. Due to the simplicity of the entire system, routine maintenance consisted of brief pre-flight and post-flight checks, which were easily accomplished in a short period of time between operations. Airplane turn around times depended solely on the time required for refueling.

No engine discrepancies were logged during the program, thus establishing the reliability of the installed power plant. Inasmuch as there is no generator and starter installed, the engine is started by hand-spinning the propeller. The engine never failed to start within two tries, even after the engine had been idle for two months. The only mechanical discrepancy encountered was a flat oleo caused by a leaking O-ring seal. The wing proved to be trouble-free and required no special treatment or techniques. Tire wear was commensurate with conventional lightweight aircraft.

This program has demonstrated the ability of the XV-8A to be operated and maintained in austere environments with minimum crew and logistic support.

STABILITY AND CONTROL

Longitudinal Characteristics

Longitudinal trim is accomplished by decreasing the wing incidence for increased speed and increasing incidence for decreasing trim speed. The available incidence range was more than adequate to trim for any flight condition, however practical limits do exist. At lower incidence angles and high speed the fabric begins to flap and produces a mild aileron oscillation of 1 to 3 cycles per second. The build-up is gradual and serves as an excellent speed warning. A minimum wing incidence of 21 degrees for aft cg and 23 degrees for forward cg locations was selected to minimize the oscillation. A limit is also required for the higher incidence angles to avoid pitch-up, which occurs at high angles of attack. Lateral control also decays as high angles of attack are approached, and the aircraft rolls off as stall speed is reached. The maximum trim wing incidence selected were 23 degrees for the aft cg and 25 degrees for the forward cg to provide adequate margins from roll off and pitch-up, and to give elevator maneuvering capability below the trim speed. With these wing incidence settings, satisfactory limit speeds are obtained with maximum elevator throws. Since the speed range is small, it is practical to set the trim for the entire flight based on the horizontal cg location. Flight path control is obtained in the conventional manner with elevator and power variations. The level flight trim speed versus wing incidence angles for forward, mid, and aft cg locations are shown in Figures 21 through 24. Elevator angles versus airspeed for several wing incidence angles and cg locations are plotted in Figures 31 through 34. The maximum and minimum speed limits are also shown.

The pilot's comments (on static longitudinal stability) indicate light elevator forces with positive stability throughout. Figures 35 and 36 present stick force versus airspeed for a constant trim setting during climb, cruise, and approach. The slope of the force curve is similar for the climb and cruise conditions at 2 pounds/mile per hour speed change. At idle power, the force gradient becomes more positive with 4 - 5 pounds per mile per hour speed variation. Stick force/g data was not obtained due to the low g-maneuvering capability of the aircraft.

The maximum load factor recorded during any maneuver was 1.1 to 1.2 g's. This in no way limits the maneuvering capability of the airplane, since the turning characteristics of the flexible wing are excellent.

The long period dynamic longitudinal stability characteristics are shown in Figures 37 and 38. The times for the pitch oscillations to damp to one-half amplitude for the aft cg conditions during climb and cruise average 8.5 seconds, compared to a predicted value of 10 seconds. The cycles required to damp to one-half amplitude for the same points averages .7 cycles, comparing closely with the predicted value of .66 cycles, (Table 6).

The short period dynamic longitudinal stability was reported to be excellent by the pilot. A typical plot is shown in Figure 39. The recovery of the elevator from the up-elevator pulse appears to be dead beat, and the response of the aircraft does not show any short period oscillation characteristics. It is concluded that the amplitude of the short period oscillation is too small to be significant and is not shown by the instrumentation.

The effect of power reduction on trim is quite significant. Due to the high thrust line, an engine power decrease will produce a nose-up pitching moment. The power chop data presented in Figure 40 indicates approximately 8 degrees of down elevator are required to maintain trim speed for a rapid power reduction from take-off to idle setting. This compares favorably with a predicted value of 10 degrees down elevator for a complete power failure. The rapid application of take-off power produces a corresponding nose-down pitch and the data indicates approximately 7 degrees of up elevator from trim would be required to maintain trim speed.

Gross Weight = 2300 LB
 Fwd C.G., F.S. 98.5

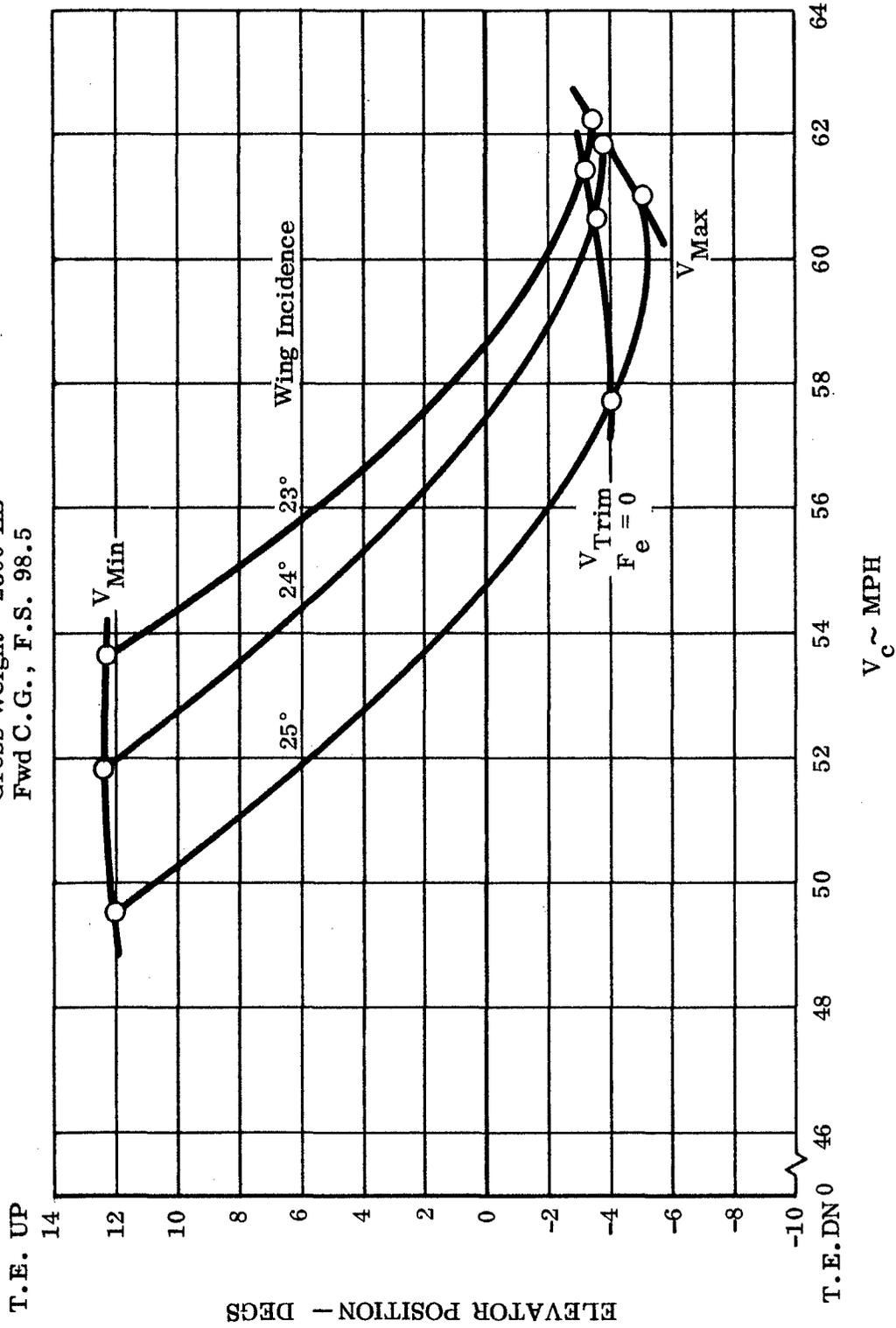


Figure 31. Elevator Angle vs. Velocity - Fwd. C.G. 2300 lb.

Gross Weight = 2300 LB
 Nom C.G., F.S. 103

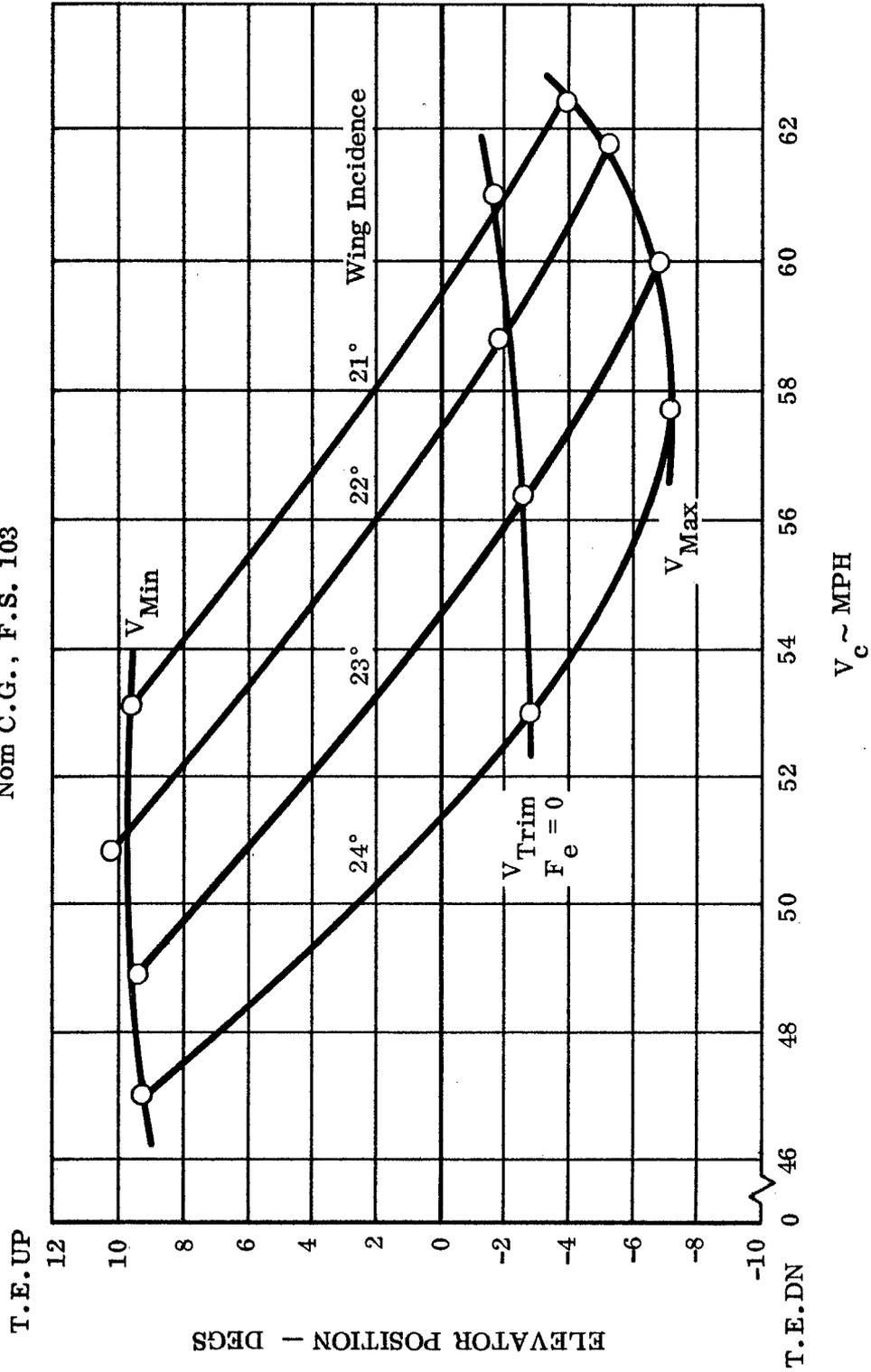


Figure 32. Elevator Angles vs. Velocity - Nom. CG 2300 Lb.

Gross Weight = 2300 LB
 Aft. C.G., F.S. 106

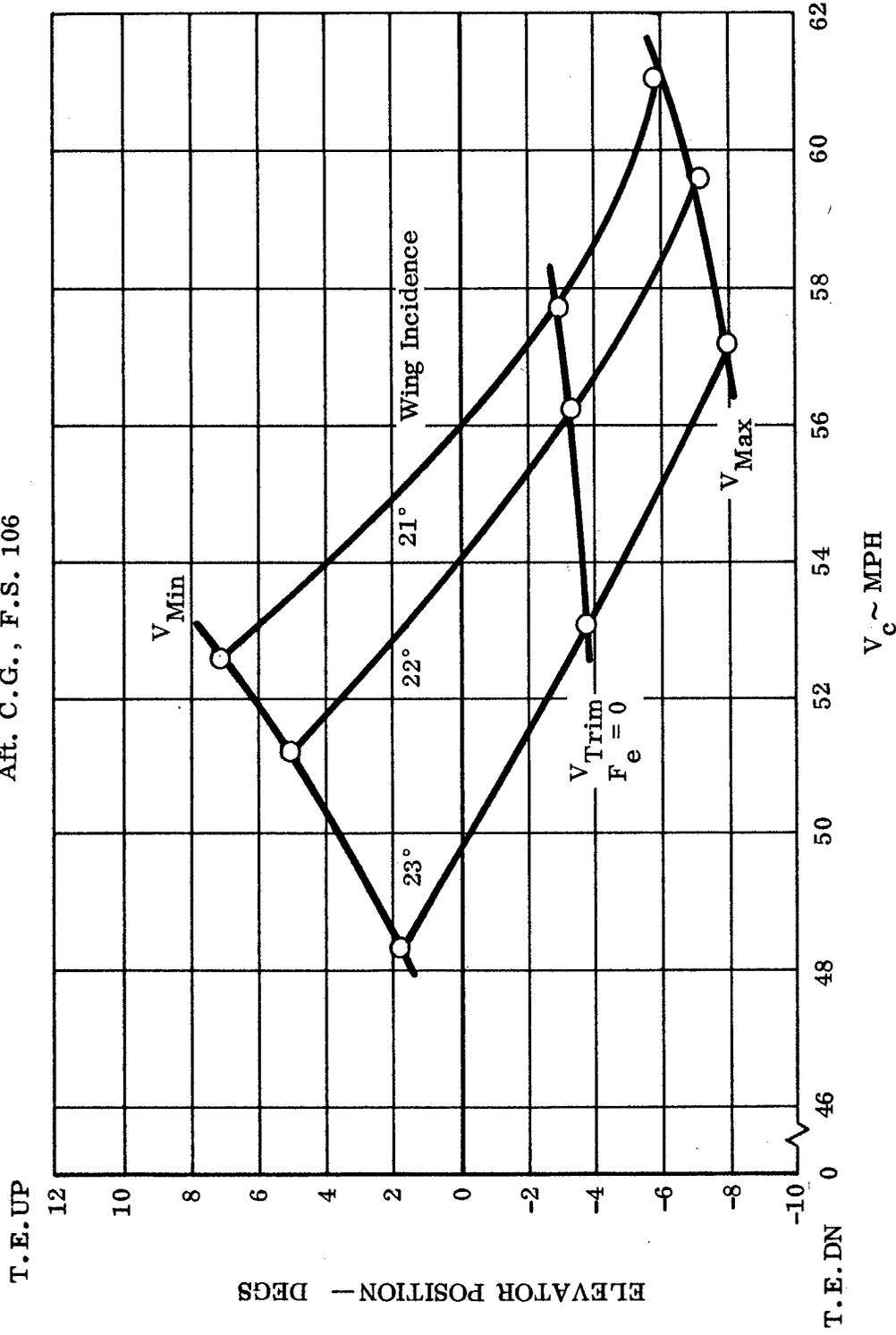


Figure 33. Elevator Angles vs. Velocity - Aft CG 2300 Lb.

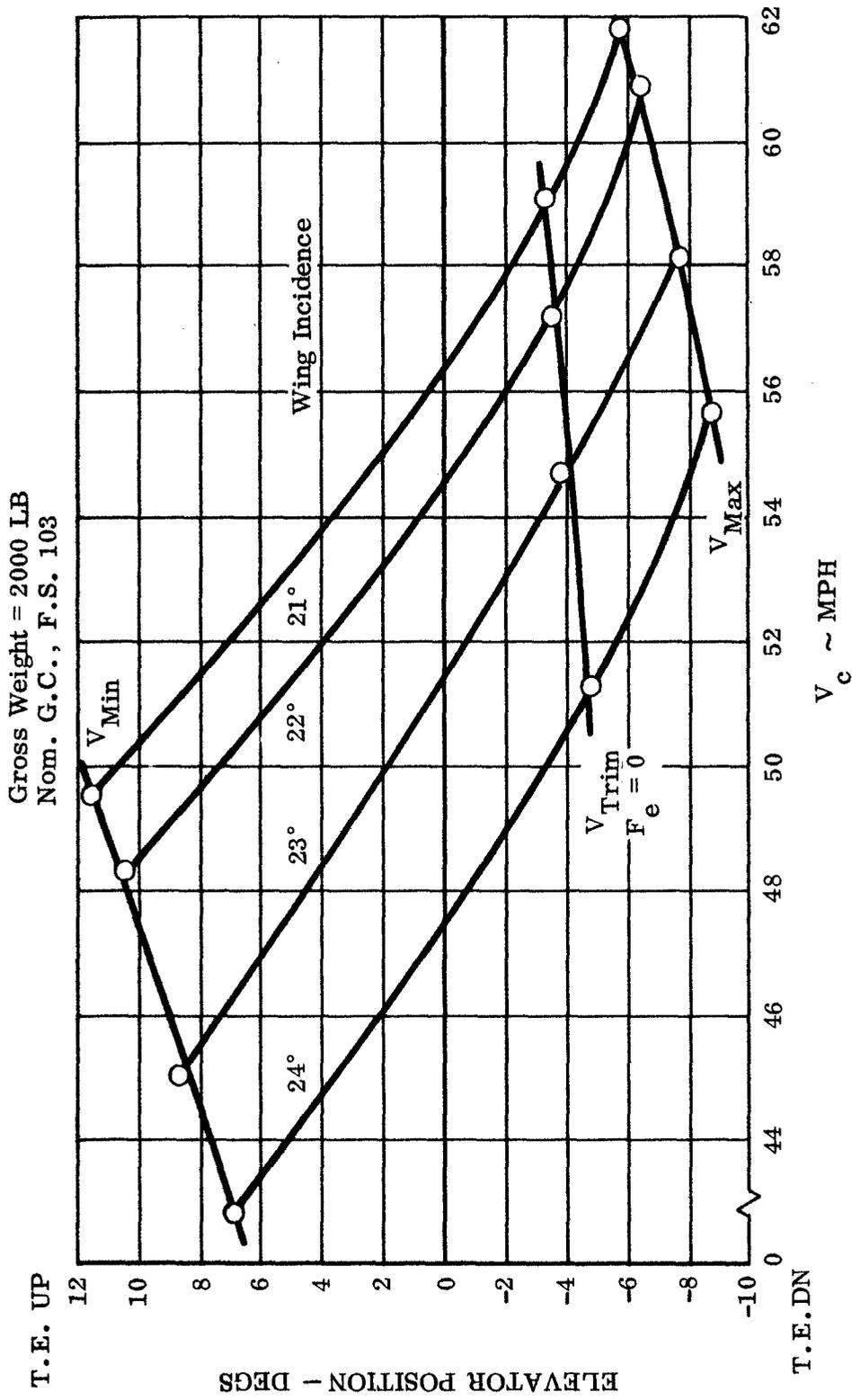


Figure 34. Elevator Angles vs. Velocity - Nom. CG 2000 Lb.

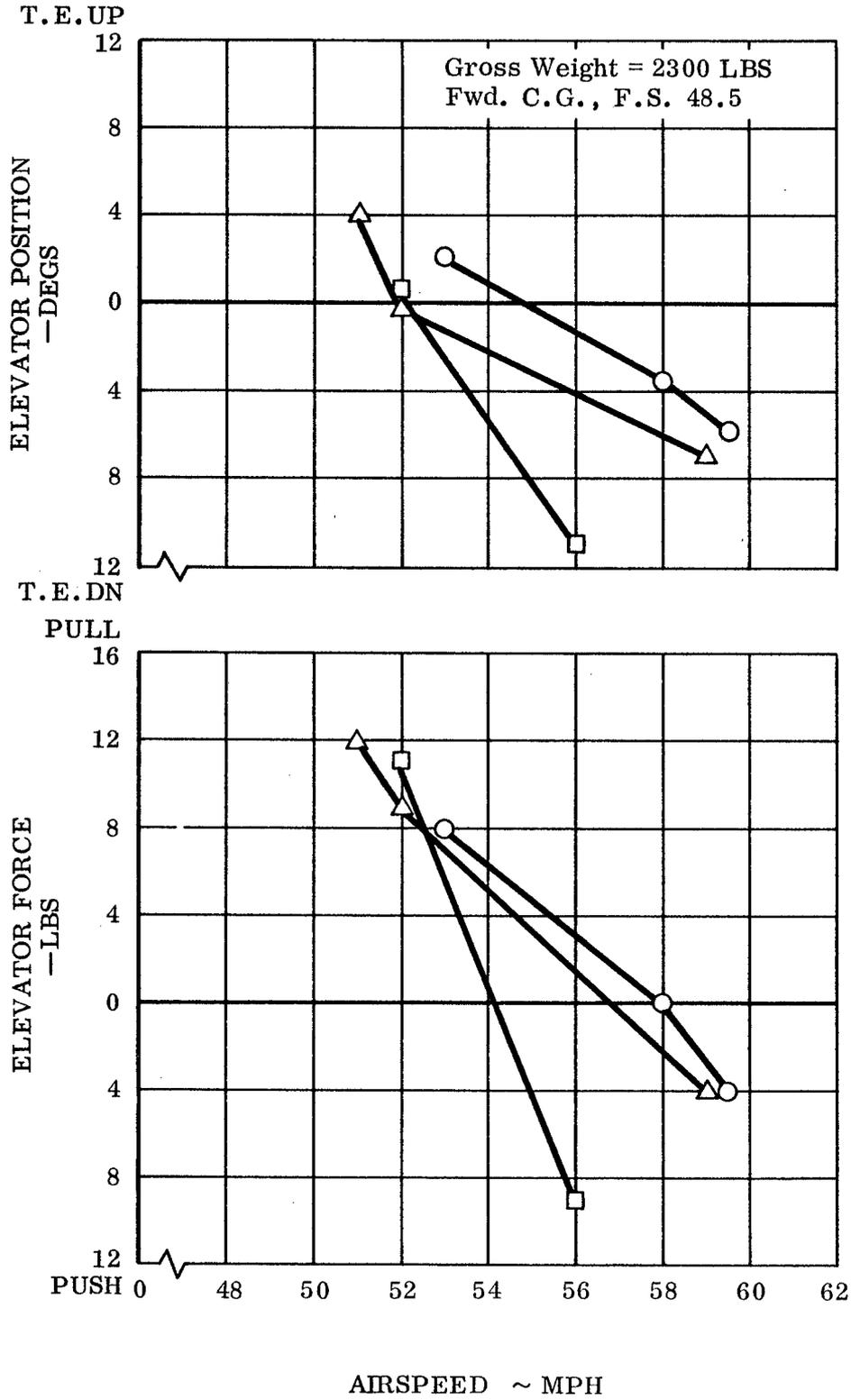


Figure 35. Static Longitudinal Stability - Fwd. C.G.

Gross Weight = 2300 LB
Aft C.G., F.S. 106

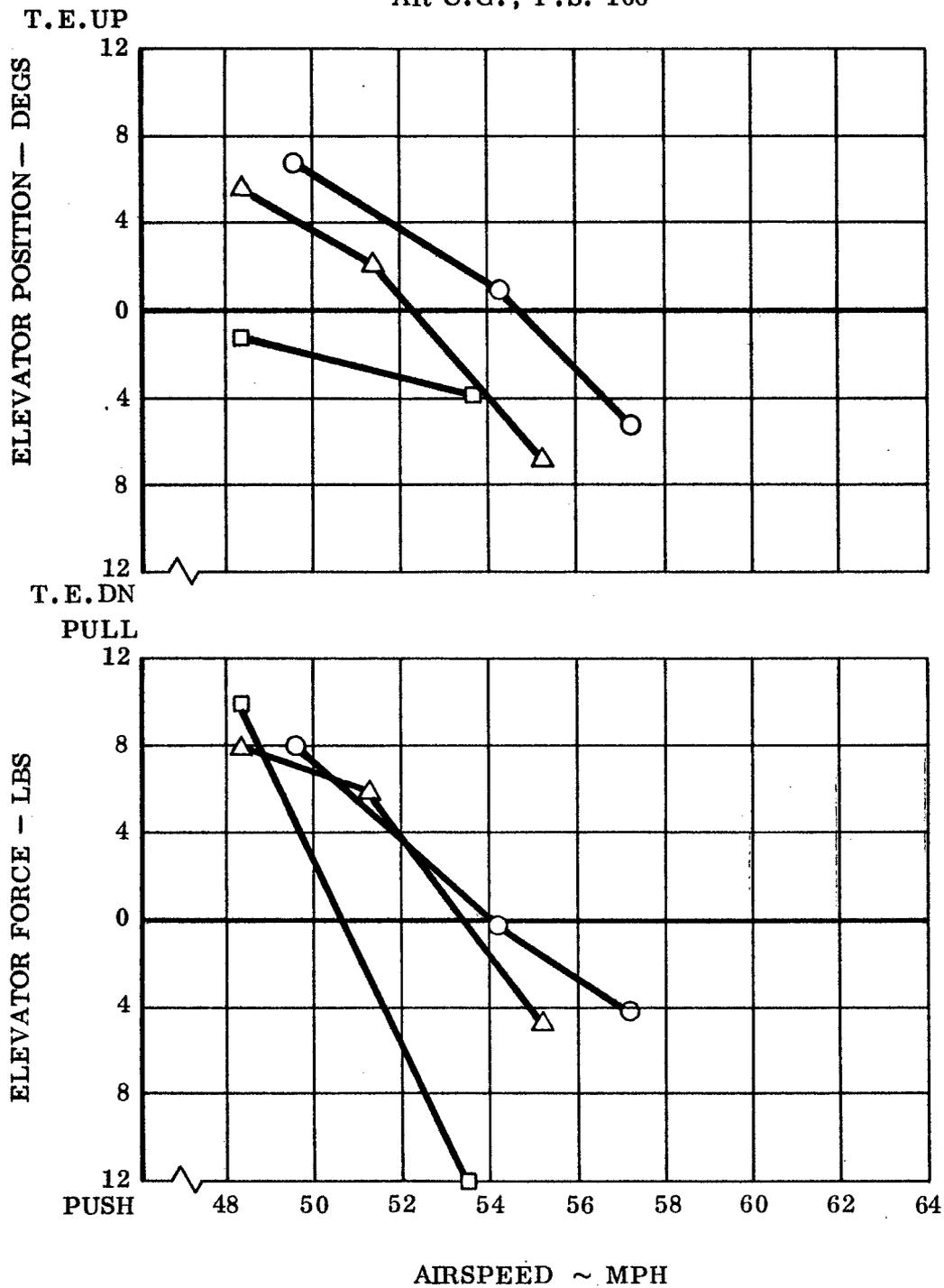


Figure 36. Static Longitudinal Stability - Aft. C.G.

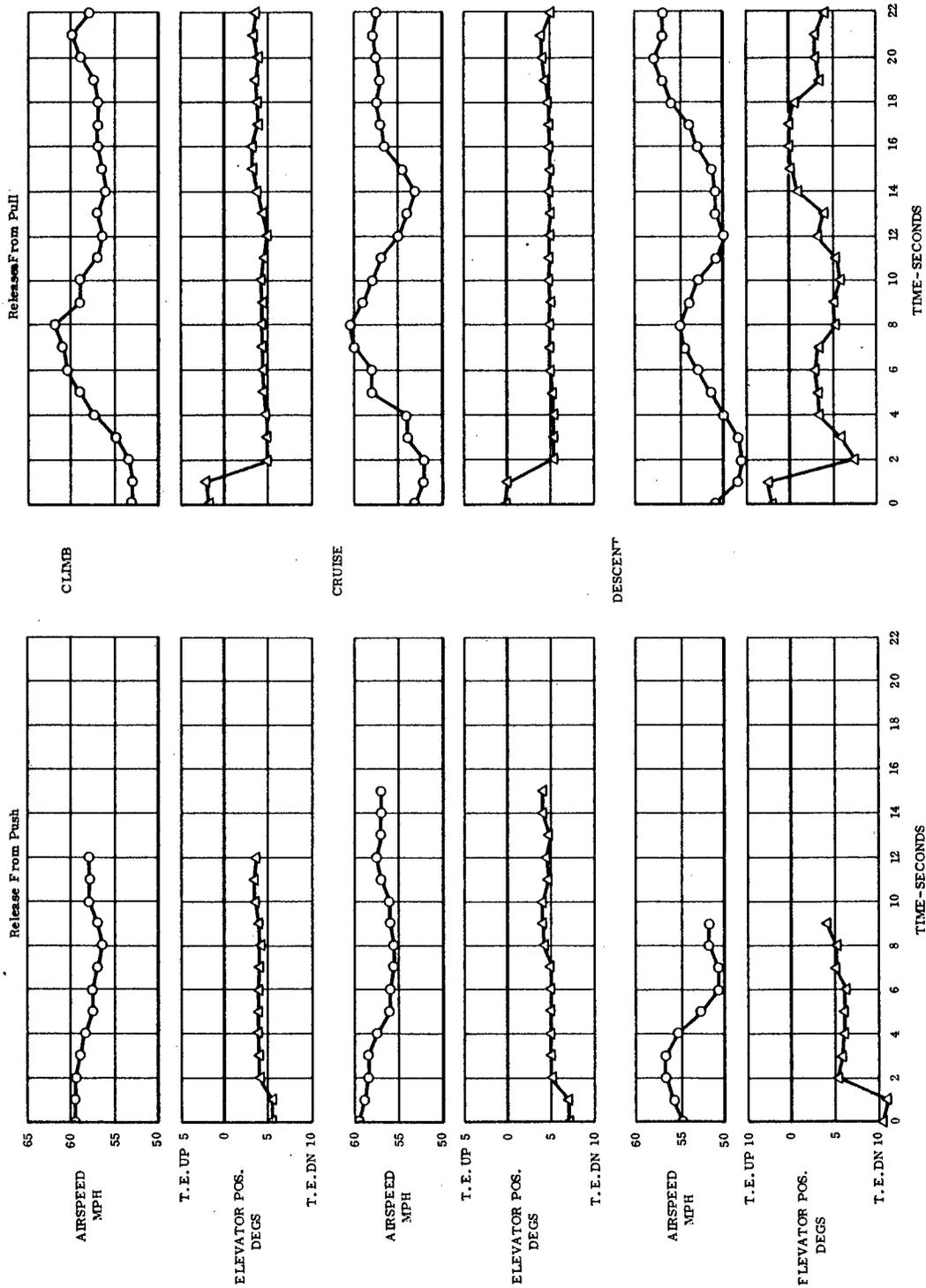


Figure 37. Long Period Dynamic Longitudinal Stability
(PHugoid) Fwd. C. G.

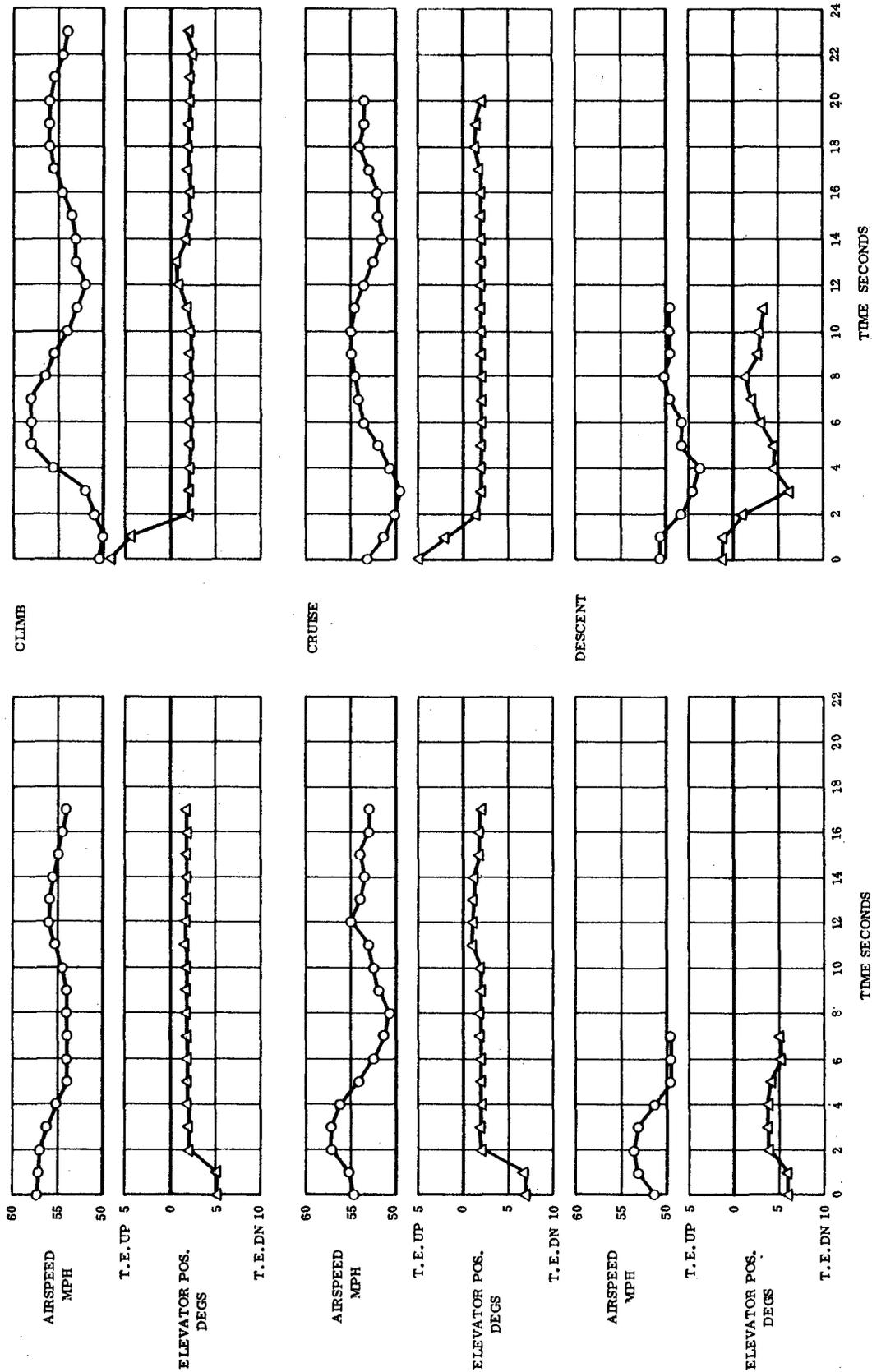


Figure 38. Long Period Dynamic Longitudinal Stability
(PHugoid) Aft. C. G.

**Table 6. Long Period Longitudinal Dynamic Stability
(PHugoid)**

	Time to Damp to 1/2 Amp	Cycles to Damp to 1/2 Amp	Predicted	
			Time	Cycles
Climb Release from Push	10	.77	9.8	.65
Climb Release from Pull	6	.45	9.7	.63
Cruise Release from Push	7	.64	10.1	.68
Cruise Release from Pull	11	.92	10.3	.70
Average Values	8.5	.7	10	.66

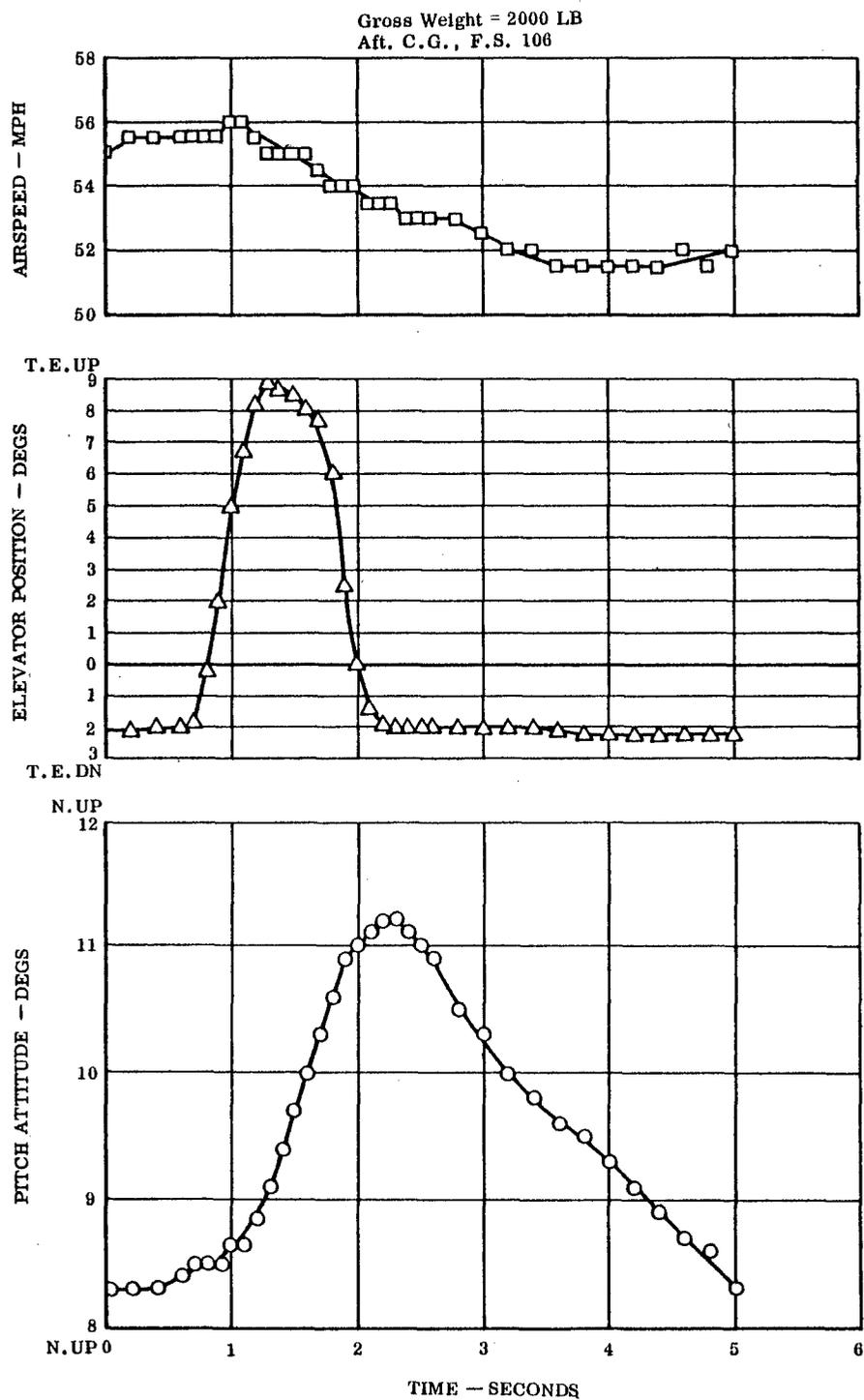


Figure 39. Short Period Dynamic Longitudinal Stability

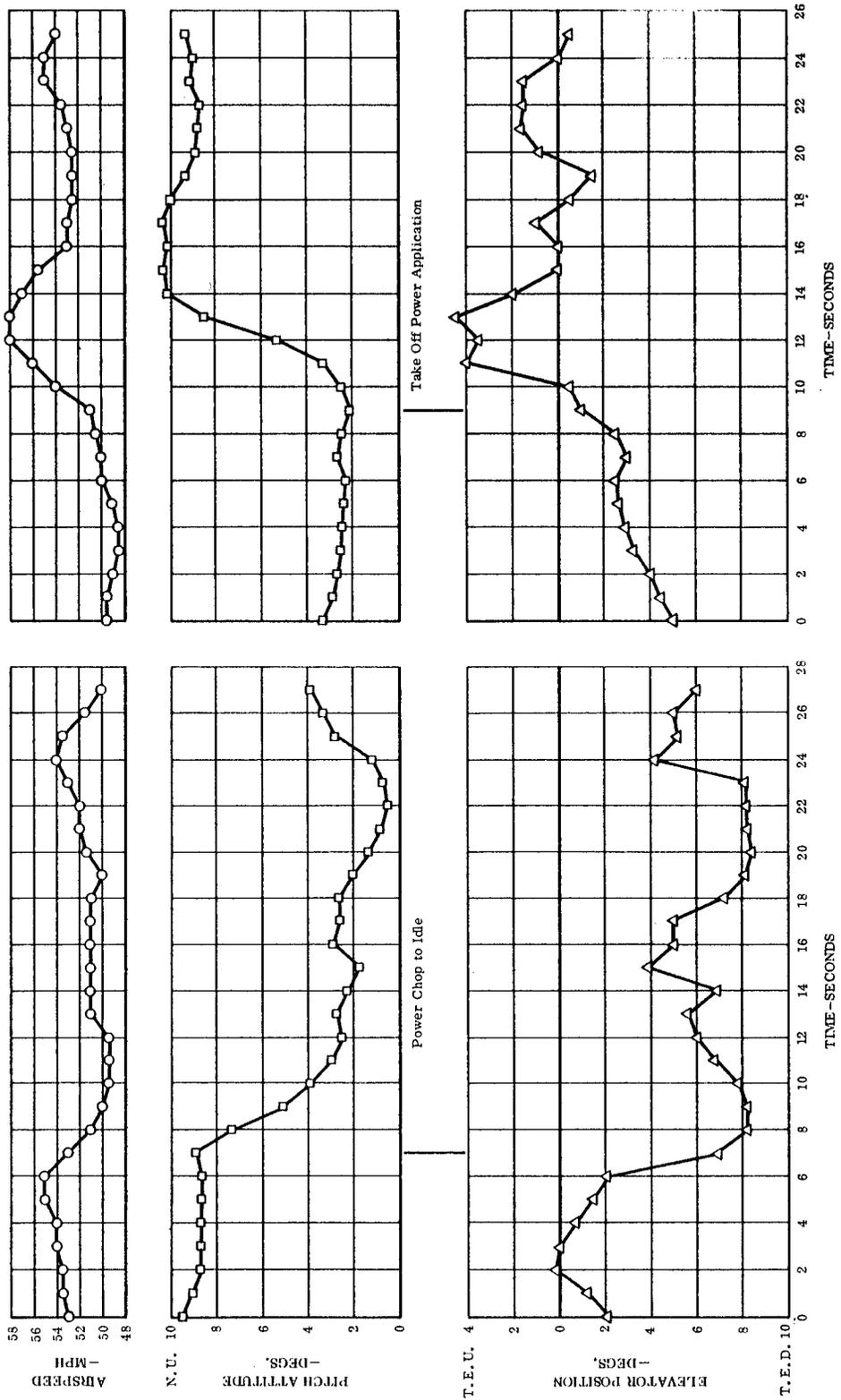


Figure 40. Longitudinal Controllability During Power Changes

LATERAL-DIRECTIONAL CHARACTERISTICS

The first one-half control wheel throw produces lateral control through conventional aileron motion. Continued wheel motion produces additional rolling control by moving the wing itself. During rapid roll maneuvers using full wheel, an abrupt increase in force gradient associated with moving the wing is apparent. The wheel force required to move through this artificial stop increases from about 12 to 25 pounds. Data from bank-to-bank rolls using one-half and full wheel deflections are presented in Figures 41 through 44. The average roll rate is 4 to 5 degrees/second for one-half wheel displacement and 6 to 8 degrees/second for full wheel. The pilot report, that very little adverse yaw is apparent, is corroborated by the data indication of less than 4 degree sideslip angle for full control rolls. Bank angles of 20 to 30 degrees are readily obtained using ailerons-alone. During the course of the test program, the aileron control system alone appeared adequate for roll control. Manual movement of the wing occurred only during tests specifically for full roll tests. The turn radius obtained with a 20 to 30 degree bank is small enough for any normal purpose.

The aircraft has good positive spiral stability with no tendency to wrap-up in steep turns. The low wing loading prevents any significant build up of acceleration loads, no matter how tight the turn. Also, lateral and longitudinal control forces become excessive for sustained pilot comfort when lateral directional maneuvers are attempted beyond normal performance requirements. This normal performance envelope, with acceptable control forces and good control harmony, provides a very tight turning radius and speed control, which should be more than satisfactory for any flight conditions or requirements.

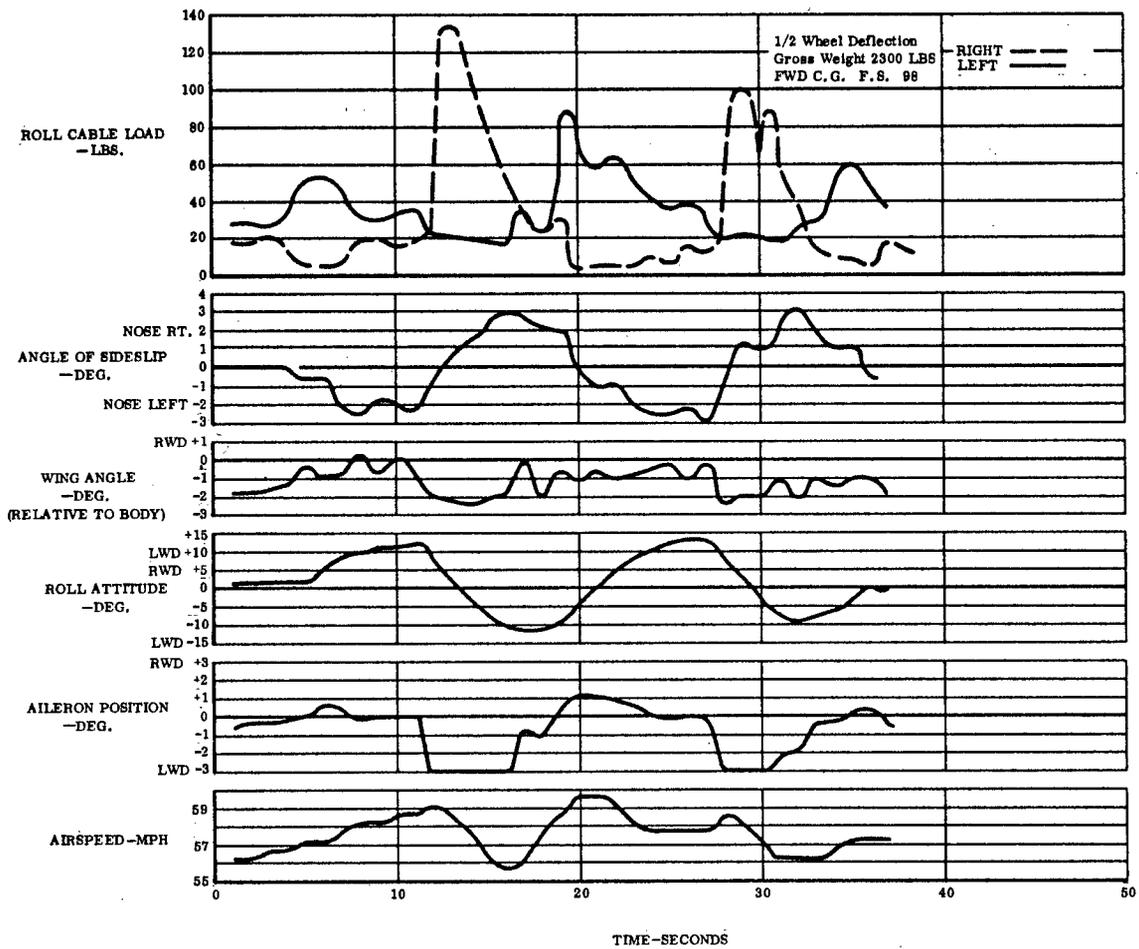


Figure 41. Bank to Bank Pull - 1/2 Wheel Deflection - Fwd C. G.

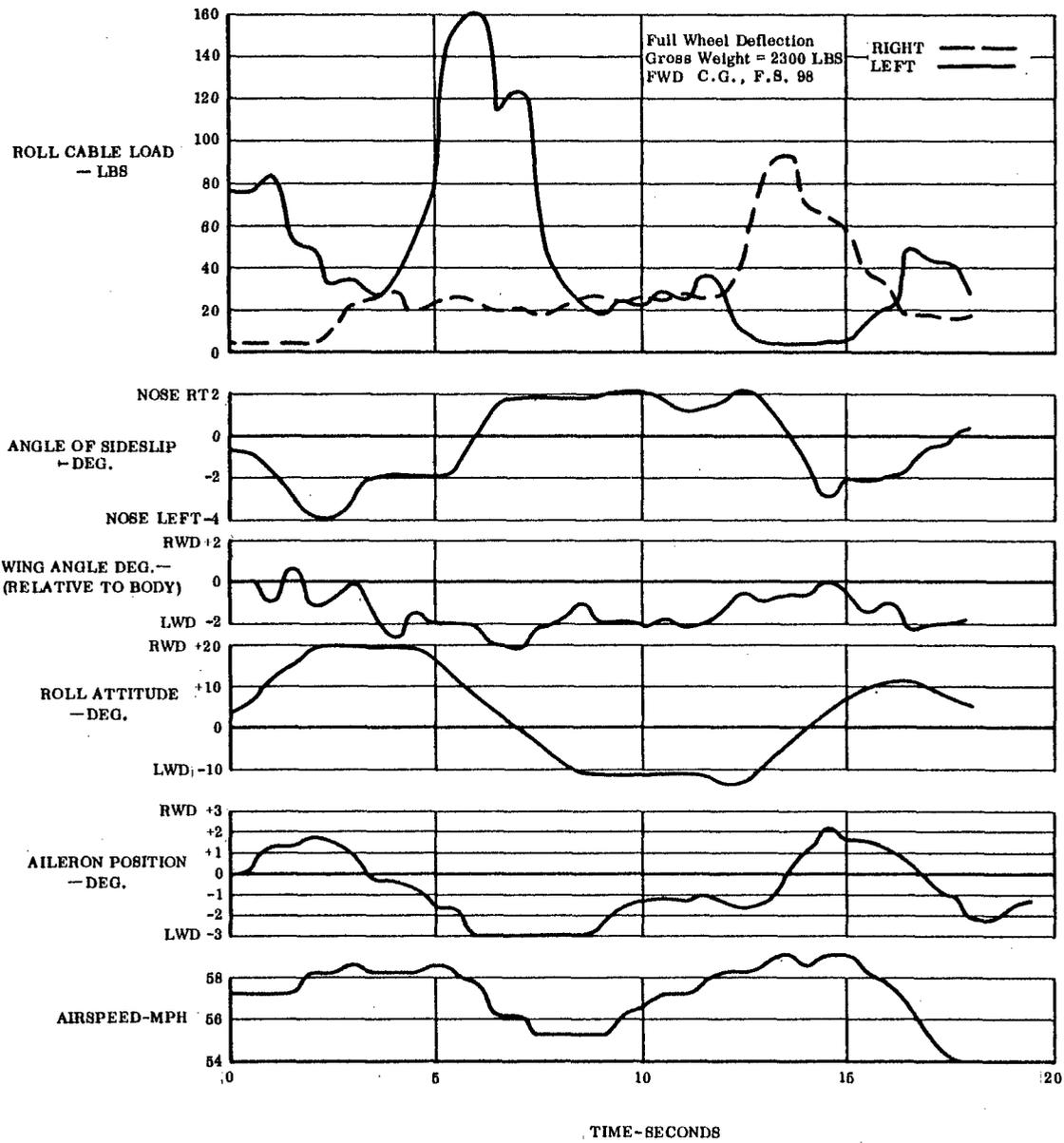


Figure 42. Bank to Bank Roll - Full Wheel Deflection - Fwd. C. G.

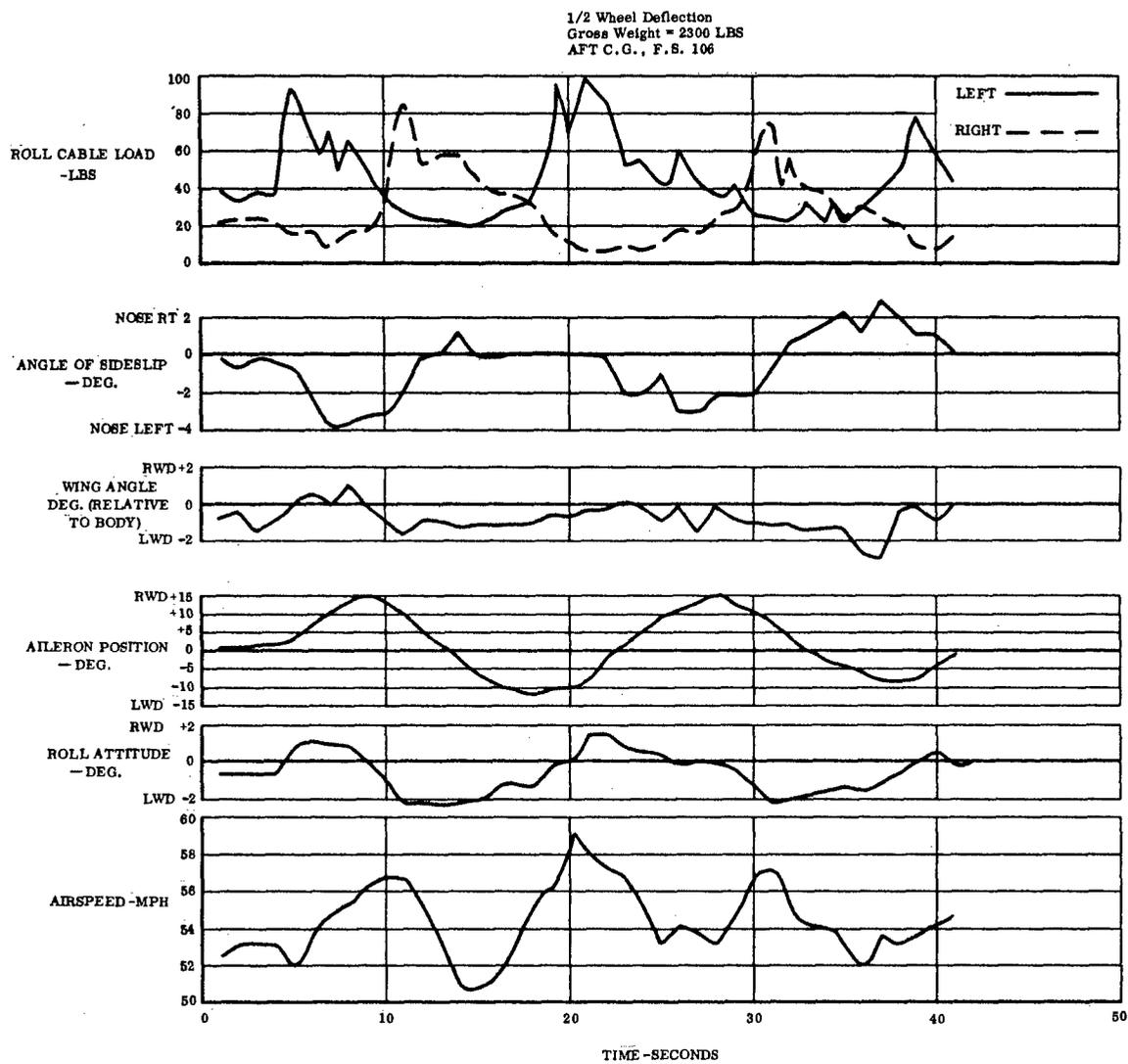


Figure 43. Bank to Bank Roll - 1/2 Wheel Deflection - Aft. C. G.

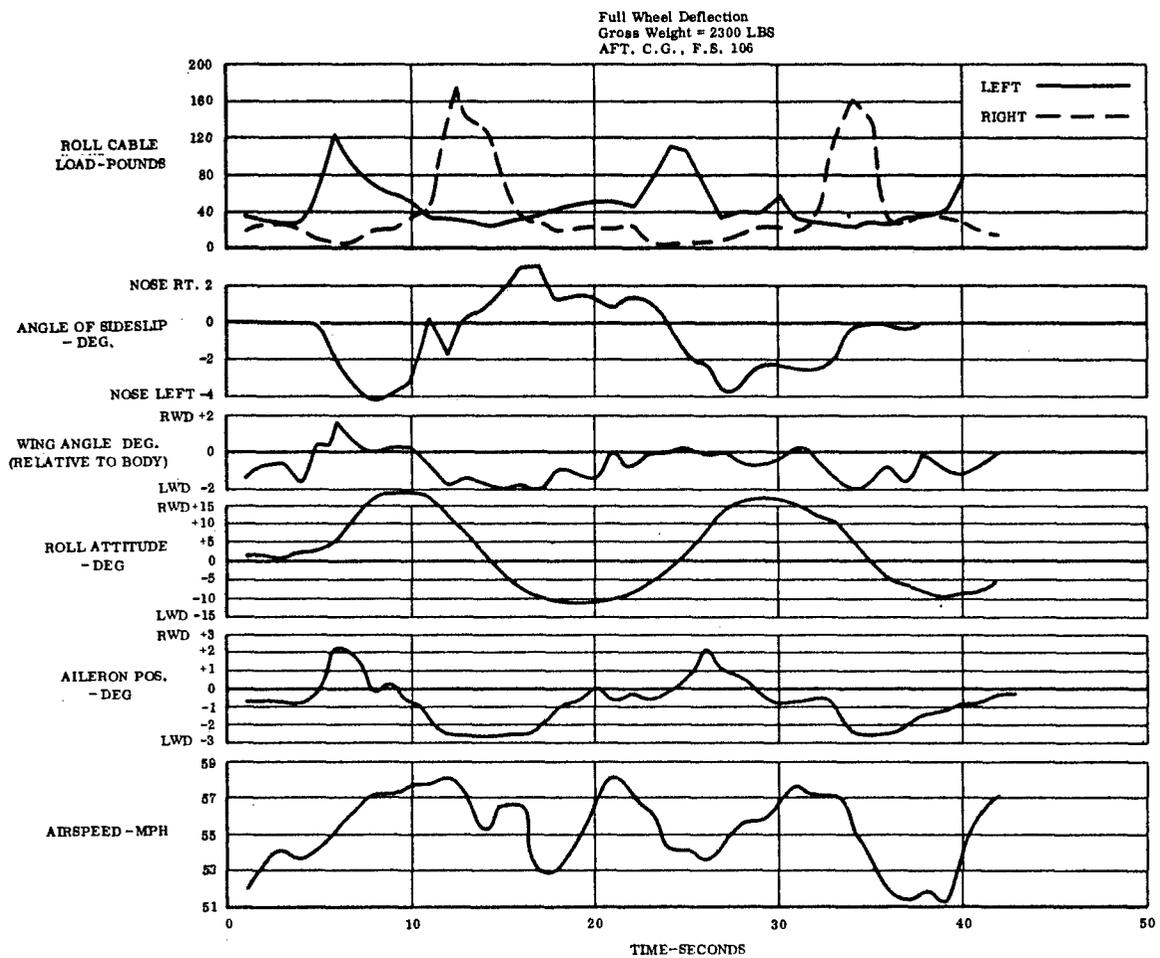


Figure 44. Bank to Bank Roll - Full Wheel Deflection - Aft. C.G.

FIXED WING OPERATION

One-taxi operation was conducted to observe preliminary roll system effectiveness with the wing fixed relative to the fuselage, thereby utilizing only aileron action for lateral control. Initial high speed taxi runs, and low level flights down the runway were made with gradually increasing bank angles and S-turns. An aileron-only lateral control system appeared feasible, but the control power in this configuration was marginal and would be acceptable only under calm wind conditions. Larger ailerons and/or more aileron deflection are necessary for additional control power to maintain a cross-wind handling capability. This became obvious on the last taxi run when a sharp gust from the right resulted in a complete loss of directional control. Available lateral control power was insufficient to maintain or regain control. Recovery was made by kicking the nose wheel left with drift and then right to regain control.

More testing with a modified aileron control system is required before a definite conclusion as to the feasibility and/or practicability of an aileron-only lateral control system can be made.

APPENDIX, FLIGHT TEST OPERATIONS

The following individual Flight Test Reports are compiled from Pilot Remark Summaries. These remarks cover individual flights that provide a time-history of the program, and include flight objectives and configuration changes.

Flight Test Operation No. 164-1-2

Flex Wing Fleep, February 24, 1964

OBJECTIVES:

Pilot re-familiarization, ground handling, low/high speed taxi runs. Determination of longitudinal control power available for nose gear lift-off as a function of cg and i_w .

CONFIGURATION AND CHANGES:

Wing re-positioned 12 inches forward relative to body. Split metal auxiliary elevator installed. Permanent battens installed on wing trailing edge. Steel aileron hinges installed. Gross weight 1945 pounds, cg 101.0 and 105.8.

FLIGHT RESULTS AND COMMENTS:

Low speed handling qualities were unchanged from the original FLEEP flight test program. Twelve high speed taxi runs were conducted; 10 at forward cg (101.0): three runs at each of two i_w (20° and 22°) at $V_O = 30, 35$ and 40 miles per hour. Little rotation was observed with maximum back stick. Runs at greater i_w (24° and 26°) resulted in lift-offs and satisfactory longitudinal control response. Scheduled taxi runs were not completed at aft cg (105.8) because of increasing cross winds with gusts above ten knots; however, the nose gear can be rotated off first with $i_w = 22^\circ$.

DATA AND RECORDS:

Functional check of oscillograph instrumentation.

ENGINE TIME:

1 hour and 21 minutes.

FLIGHT TIME:

1 hour and 5 minutes (taxi only).

Flight Test Operation No. 164-2-2

Flex Wing Fleep, February 25, 1964

OBJECTIVES:

Complete taxi tests at aft cg and continue longitudinal control investigation.

CONFIGURATION AND CHANGES:

Gross weight 1945 pounds, cg 105.8.

FLIGHT RESULTS AND COMMENTS:

Twelve high speed taxi runs at $i_w = 22^\circ$, 23° , 24° , and 26° were conducted which included five lift-offs. $i_w = 23^\circ$ appears to be maximum for satisfactory longitudinal control at aft cg during rotation for T.O. and landing. Three time-distance runs were made for a rough air speed calibration. The last T.O. was made at maximum rpm with a climb to 100 feet where lateral response and control were checked and found to be satisfactory. Aft og with proper i_w produces good attitude and forces for rotation.

DATA AND RECORDS:

None

ENGINE TIME:

1 hour and 30 minutes.

FLIGHT TIME:

1 hour and 15 minutes (taxi only).

Flight Test Operation No. 164-3-2

Flex Wing Fleep, February 27, 1964

OBJECTIVES:

First flight to altitude and general handling qualities investigation.

CONFIGURATION AND CHANGES:

Gross weight 1945 pounds, cg 105.8, engine plugs cleaned, panel instruments recalibrated.

FLIGHT RESULTS AND COMMENTS:

One lift-off and low altitude run was made to check the recalibrated instruments followed by a maximum power takeoff and climb to 2500 feet. Basic speed power, trim and stability and control checks were made with good results. A 3-4 cps control wheel oscillation of 5-10° amplitude was observed near straight and level V maximum. Power or air speed reduction quickly eliminates this condition probably caused by traveling wing fabric waves leaving the trailing edges causing aileron movement as loads are relieved. These waves were noted by the chase helicopter assigned for this flight.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

56 minutes.

FLIGHT TIME:

35 minutes.

Flight Test Operation No. 164-4-2

Flex Wing Fleep, February 28, 1964

OBJECTIVES:

Airspeed altimeter calibration using tower fly-by method.

CONFIGURATION AND CHANGES:

Gross weight 1945 pounds, cg 105.8.

FLIGHT RESULTS AND COMMENTS:

Ten standard calibration runs at 465-480 feet/H_p were made at V₀ of 35.5, 38, 41, 44, and 47 mph. Random, but infrequent lateral wheel pulses, were again observed at 47 mph which was considered a limiting air speed factor for this test. Ground observers were able to observe the wing fabric waves which probably are causing the lateral control feed-back.

DATA AND RECORDS:

Ground crew observations only, tower fly-by and runway time distance.

ENGINE TIME:

1 hour and 11 minutes.

FLIGHT TIME:

50 minutes.

Flight Test Operation No. 164-5-2

Flex Wing Fleep, February 28, 1964

OBJECTIVES:

Initial company test pilot checkout - taxi tests and lift-offs.

CONFIGURATION AND CHANGES:

Gross weight 1960 pounds, cg 103.

FLIGHT RESULTS AND COMMENTS:

Eleven taxi runs were conducted at $i_w = 22, 23, 24$ and 26° ; 30, 35, and 40 mph V_o . Four lift-offs and low altitude flights were included. 23° appears to be the optimum wing incidence setting for nominal cg and results in good longitudinal control. 26° is not satisfactory and results in lift-offs at air speeds below the effective longitudinal control threshold.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

47 minutes.

FLIGHT TIME:

40 minutes.

Flight Test Operation No. 164-6-2

Flex Wing Fleep, March 2, 1964

OBJECTIVES:

Evaluate lateral trim and wheel position effects of right wing bolt rope tension adjustment. Obtain camera film observation of high speed lateral oscillation.

CONFIGURATION AND CHANGES:

Gross weight 1945 pounds, cg 105.8. Right wing bolt rope shortened 1/2 inch. Elevator and rudder control rods adjusted to eliminate excessive play.

FLIGHT RESULTS AND COMMENTS:

One lift-off and low altitude runway flight revealed no adverse trim effect from the bolt rope adjustment. A maximum power climb and flight at 2000 feet was inconclusive with respect to trim effect because of turbulence. Two V_{max} camera runs were made at 48-51 mph V_0 where lateral wheel oscillation was observed and recorded.

DATA AND RECORDS:

Keel mounted camera records of aileron oscillation.

ENGINE TIME:

26 minutes.

FLIGHT TIME:

15 minutes.

Flight Test Operation No. 164-7-2

Flex Wing Fleep, March 2, 1964

OBJECTIVES:

Additional taxi and lift-off tests for pilot familiarization plus investigation of longitudinal control characteristics at forward cg (99.0).

CONFIGURATION AND CHANGES:

Gross weight 2000 pounds, cg 103.0 and 99.0.

FLIGHT RESULTS AND COMMENTS:

Twenty-two (22) taxi and lift-off runs were conducted at two cg positions, various i_w and air speeds. Forward cg position produced the anticipated level attitude on lift-off and reduced the amount of longitudinal control available for flare and landing. $24^\circ i_w$ is a comfortable maximum with 25° and 26° unacceptable. Flight confirmed the control system ability to safely and comfortably handle this particular cg range. First real experience with cross wind landings ($70^\circ - 80^\circ$ at 6-8 K) near the end of the period provided valuable training for future operations.

DATA AND RECORDS:

Oscillograph and camera records taken.

ENGINE TIME:

1 hour and 10 minutes.

FLIGHT TIME:

1 hour and 5 minutes.

Flight Test Operation No. 164-8-2

Flex Wing Fleep, March 4, 1964

OBJECTIVES:

First flight to altitude and general handling qualities investigation.

CONFIGURATION AND CHANGES:

Gross weight 2012 pounds, cg 103.0. Rate of climb indicator installed on panel.

FLIGHT RESULTS AND COMMENTS:

Two runway flights at 50-100 ft. altitude with S turns and normal landings, $i_w = 23^\circ$ were conducted followed by maximum rpm (2750) climb to 2500 feet. General handling qualities proved quite satisfactory during climb, turns, level trim, static and dynamic longitudinal checks, descent and landing. Trim power changes are conventional but slow in pitch response stick free. A moderate cross wind landing was made by accepting the side load on the gear set up by drift and adjusting on touchdown with nose wheel.

DATA AND RESULTS:

Oscillograph records taken.

ENGINE TIME:

56 minutes.

FLIGHT TIME:

30 minutes (+5 minutes taxi).

Flight Test Operation No. 164-9-2

Flex Wing Fleep, March 5, 1964

OBJECTIVES:

Cross wind taxi tests only.

CONFIGURATION AND CHANGES:

Gross weight 2112 pounds, cg 103.0. Fuel flow meter installed.

FLIGHT RESULTS AND COMMENTS:

A series of taxi runs were made in left and right cross winds 30° - 50° at 10-12 K. Lateral control authority over the wing can only be obtained above speeds of about 25-28 mph, which is satisfactory for safe takeoffs. Normal ground handling and taxi is possible if done more slowly than under calm conditions. Effects of various wing incidence settings on handling were observed. $i_w = 18^{\circ}$ is minimum for keeping wing filled to prevent flapping. Taxi in strong winds at 0° wing incidence is practical, but with caution due to flapping and resulting structure loads. Control power available appears sufficient to properly handle gust loads with the extremely effective nose gear steering a big help.

DATA AND RECORDS:

None

ENGINE TIME:

35 minutes

FLIGHT TIME:

25 minutes (taxi only).

Flight Test Operation No. 164-10-2

Flex Wing Fleep, March 3, 1964

OBJECTIVES: Flight envelope definition, speed power points.

CONFIGURATION AND CHANGES:

Gross weight 2012 pounds, cg 103.0.

FLIGHT RESULTS AND COMMENTS:

A series of speed power data points was recorded at 3000 feet with $i_w = 21, 22, 23,$ and 24° . Three speeds V_{trim} , V_{max} , and V_{min} were checked at each i_w . Also timed climb and descent data was recorded at $i_w = 22, 23,$ and 24° . High and low speed boundaries were observed as follows: High speed, $21^\circ i_w$, 2550 rpm, 50 mph with a mild lateral aileron oscillation at 2-3 cps caused by traveling fabric waves leaving trailing edge and moving ailerons slightly which causes control wheel feed back. This flight condition falls well beyond normal operating envelope and requires unusual settings of stick and power (full forward and near maximum rpm) to enter. Low speed stall requires $24^\circ i_w$, 2350 rpm, 33 mph V_0 and results in slow right yaw (torque effect) followed by an easily corrected roll to the right. This flight condition is also most difficult to enter requiring full back stick with high forces. The level stall can be induced at 23° with more difficulty but not at 22° or 21° due to control power and stick travel limitations. V_{max} level flight similarly cannot be reached at 23 or $24^\circ i_w$ because the machine will climb with max. power and full forward stick.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

1 hour and 21 minutes

FLIGHT TIME:

1 hour and 5 minutes.

Flight Test Operation No. 164-11-2

Flex Wing Fleep, March 9, 1964

OBJECTIVES:

Check airspeed system following repair and conduct airspeed calibration using tower fly-by and manual methods.

CONFIGURATION AND CHANGES:

Gross weight 2012 pounds, cg 102.9. Leak repaired in pressure side of pitot system.

FLIGHT RESULTS AND COMMENTS:

The first flight was terminated during the climb due to an air speed system failure due to a crimp in the pressure lines. When flight was resumed, all IAS readings were observed to have shifted up by 4-5 mph. All future V_O will now reflect this change with the new $23^\circ i_w$ $V_{min} = 39$ mph and $V_{max} = 54$ mph. Eight air speed calibration runs were conducted at V_O of 40 to 49 mph.

DATA AND RECORDS:

Ground crew observations tower fly-by and runway time distance.

ENGINE TIME:

1 hour and 44 minutes.

FLIGHT TIME:

1 hour and 15 minutes.

Flight Test Operation No. 164-12-2

Flex Wing Fleep, March 10, 1964

OBJECTIVES:

Recheck flight envelope through speed power following air speed system work and conduct air speed calibration.

CONFIGURATION AND CHANGES:

Gross weight 2012 pounds, cg 102.9, air speed system replumbed and leak checked. Pilot's wing incidence indicator recalibrated.

FLIGHT RESULTS AND COMMENTS:

Twelve (12) speed points were recorded at 3000 ft. which confirmed the air speed system and operating envelope with the 4-5 mph higher V_o as previously noted. V_{max} and V_{min} characteristics were further explored with good repeatable data results. Eight ground course method air speed calibration runs were conducted.

DATA AND RECORDS:

Oscillograph and ground observer data.

ENGINE TIME:

1 hour and 45 minutes.

FLIGHT TIME:

1 hour and 40 minutes.

Flight Test Operation No. 164-13-2

Flex Wing Fleep, March 11, 1964

OBJECTIVES:

Completion of 3000 feet speed power data and air speed calibration.

CONFIGURATION AND CHANGES:

Gross weight 2012 pounds, cg 102.9.

FLIGHT RESULTS AND COMMENTS:

Eight additional speed power points were recorded with good repeatable results. Air speed calibration runs were conducted in calm air at 42, 48, and 52.5 mph V_0 . Moderate residual prop-wash turbulence was encountered on final landing several minutes after a C-130 had landed on the same runway. A wave-off was required and greater than normal landing intervals are advised due to this low wing loading system's reaction to turbulence.

DATA AND RECORDS:

Oscillograph and ground observer data.

ENGINE TIME:

1 hour and 15 minutes.

FLIGHT TIME:

1 hour and 2 minutes.

Flight Test Operation No. 164-14-2

Flex Wing Fleep, March 11, 1964

OBJECTIVES:

Establish flight envelope and speed power data at 5000 feet. Climb and descent data 1000-5000 feet.

CONFIGURATION AND CHANGES:

Gross weight 2012 pounds, cg 102.9.

FLIGHT RESULTS AND COMMENTS:

Climb and descent data at $i_w = 22^\circ$ suggests that this i_w may produce good performance but a flat altitude and high V_o (51 mph). Twenty speed power data points at 5000 feet and four i_w settings were normal and fall according to the anticipated envelope extension. No lateral oscillation was noted at any of the V_{max} points, although airframe and wing buffet indicated that it was close. V stall responses were normal and repeatable.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

1 hour and 13 minutes.

FLIGHT TIME:

1 hour and 5 minutes.

Flight Test Operation No. 164-15-2

Flex Wing Fleep, March 12, 1964

OBJECTIVES:

Climb and descent data.

CONFIGURATION AND CHANGES:

Gross weight 2016 pounds, cg 102.9.

FLIGHT RESULTS AND COMMENTS:

Flight was not completed due to severe turbulence and rapid surface wind build-up. Four climbs and three descents for record were completed before experiencing the turbulence which apparently caused a 1000-foot $23^\circ i_w$, idle rpm (875) descent in only 30 seconds or 2000 fpm which is over twice as high as anticipated. $21^\circ i_w$ is not desirable for climb since 7-9 pounds pull is required to produce 51 mph with any climb at all. $23^\circ i_w$ is good $F_e = 0$ climb wing setting.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

41 minutes.

FLIGHT TIME:

35 minutes.

Flight Test Operation No. 164-16-2

Flex Wing Fleep, March 13, 1963

OBJECTIVES:

Rate of climb and descent tests at 3000 feet.

CONFIGURATION AND CHANGES:

Gross weight 2016 pounds, cg 102.9. Engine rpm reset to 1000 min. Right wing bolt rope extended 1/4 in. Recorder out light installed in cockpit.

FLIGHT RESULTS AND COMMENTS:

Bolt rope adjustment corrected the left turn out of trim condition. Descent data was recorded at 1800, 1600, 1400 and 1200 rpm with $i_w = 21^\circ$ and 22° producing observed rates of descent between 650 and 1000 fpm. Climb checks were also conducted at 21° and $22^\circ i_w$ before increased turbulence caused flight interruption. Additional descent data back through idle rpm is needed to confirm expected dead stick landing performance.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

1 hour and 31 minutes.

FLIGHT TIME:

1 hour and 5 minutes.

Flight Test Operation No. 164-17-2

Flex Wing Fleep, March 18, 1964

OBJECTIVES:

Longitudinal control power tests, climb data and investigation of speed envelope at new $i_w = 20^\circ$.

CONFIGURATION AND CHANGES:

Gross weight 2027 pounds, cg 102.9.

FLIGHT RESULTS AND COMMENTS:

Seven descents at 21 and 22° i_w and various low rpm's (1600, 1400, 1200) were made with full forward stick application during last portion before smooth back stick application for flare check. Forward stick during descent increases V_o by 4-6 mph from V_{trim} and provides enough elevator control power to flare for period of 3 to 4 seconds before V_o decays through V_{stall} . The body angle rotates through horizontal to slightly nose up during flare maneuver but the pilot was unable to observe any rate of descent reduction from cockpit. Level speed power checks at $i_w = 20^\circ$ produced a V_{trim} = to V_{max} of 53 mph and V_{min} of 46 mph which narrows the aircrafts already slim speed envelope. This wing incidence setting seems to serve no useful purpose and should not be considered for future operation. Standard climb data was recorded following each descent check.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

1 hour and 2 minutes.

FLIGHT TIME:

52 minutes.

Flight Test Operation No. 164-18-2

Flex Wing Fleep, March 18, 1964

OBJECTIVES:

Climb and descent data at 5000 feet.

CONFIGURATION AND CHANGES:

Gross weight 2027 pounds, cg 102.8.

FLIGHT RESULTS AND COMMENTS:

Seven climbs and five descents were conducted for record at $i_w = 21, 22,$ and 23° with ideal smooth air conditions. Idle rpm (1075) descents were included which produced rates of descent of about 1000 fpm which suggest turbulence effects on previous idle descent where rates were around 2000 fpm. Power effects checks were also conducted from idle to max. rpm with positive and mild damping and trim results.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

1 hour and 2 minutes.

FLIGHT TIME:

1 hour.

Flight Test Operation No. 164-19-2

Flex Wing Fleep, March 19, 1964

OBJECTIVES:

General handling and speed power at maximum gross weight.

CONFIGURATION AND CHANGES:

Gross weight 2300 pounds, cg 103.4. 300 pounds of shot bag ballast added.

FLIGHT RESULTS AND COMMENTS:

A series of taxi and lift-off check showed normal handling and performance with the expected effects on climb and speed power requirements at altitude. V_{max} speed points were limited by the forward stick stop using 23 and 24° i_w and 54 mph V_0 with aileron oscillation at 22° i_w . The final landing in near calm wind condition displayed a comfortable margin of elevator control power for flare using approach speed of 46-47 mph with about 1700 rpm.

DATA AND RECORDS:

Oscillograph records taken.

ENGINE TIME:

1 hour.

FLIGHT TIME:

45 minutes.

Flight Test Operation No. 164-20-2

Flex Wing Fleep, March 19, 1964

OBJECTIVES:

Maximum gross weight climb and descent data.

CONFIGURATION AND CHANGES:

Gross weight 2300 pounds, cg 103.4.

FLIGHT RESULTS AND COMMENTS:

Thirteen climb and descent checks for record at various i_w and power settings were run at 3000 and 5000 ft. Maximum gross weight performance variations were again observed as normal and expected. Landing was made with four gallons fuel remaining because of time at high power settings.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

1 hour and 26 minutes.

FLIGHT TIME:

1 hour and 20 minutes.

Flight Test Operation No. 164-21-2

Flex Wing Fleep, March 20, 1964

OBJECTIVES:

Establish flight envelope with aft. cg through speed power checks. Descent checks.

CONFIGURATION AND CHANGES:

Gross weight 2300 pounds, cg 106.14.

FLIGHT RESULTS AND COMMENTS:

Eight taxi and lift-off runs showed lighter stick forces for rotation and $i_w = 23^\circ$ was the best wing setting. The stick neutral position moved forward but general handling and performance appear normal. Moderate turbulence during the descent with aft. cg required even more use of full forward stick to damp air speed excursions approaching V_{min} .

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

1 hour and 17 minutes.

FLIGHT TIME:

55 minutes (+15 minutes taxi).

Flight Test Operation No. 164-22-2

FLEX WING FLEEP, March 23, 1964

OBJECTIVES:

Establish flight envelope at forward cg and descent checks.

CONFIGURATIONS AND CHANGES:

Gross weight 2300 pounds, cg 98.7.

FLIGHT RESULTS AND COMMENTS:

Taxi runs only were made due to rain, wind, and approaching squalls. Rain on windshield with no wiper quickly reduced visibility at taxi speeds.

DATE AND RECORDS:

None.

ENGINE TIME:

24 minutes.

FLIGHT TIME:

15 minutes (taxi only).

Flight Test Operation No. 164-23-2

Flex Wing Fleep, March 25, 1964

OBJECTIVES:

Taxi tests and flight envelope at forward cg and descent checks.

CONFIGURATION AND CHANGES:

Gross weight 2313 pounds, cg 98.55. Attitude gyro installed.

FLIGHT RESULTS AND COMMENTS:

The first full forward cg, max. gross weight flight included climbs, descents and speed power points. Taxi lift-offs indicated $24^\circ i_w$ was best for takeoff and first data climbs. $F_e = 0$ hands off climbs are impossible at 24° , about 15 pounds pull is required to hold $48-49 V_o$. Release of this force immediately produces full power dive which quickly exceeds V_{max} limit. One such release produced an abrupt attitude change from climb to about 15° nose down when back stick was re-applied at $55 V_o$. V_{trim} and V_{max} are the same at $23^\circ i_w$ and full pilot effort is required on back stick to hold V_{min} . $24^\circ i_w$ produces V_{trim} of 53 and V_{max} of 54, again almost the same with near maximum pull force required for V_{min} . The stick was not quite against the aft stop on the 23 and $24^\circ i_w V_{min}$ check. $25^\circ i_w$ speed power points were better with light push force (5-10 pounds) required on V_{max} and V_{min} (42) was defined by the beginning of directional stability decay.

The elevator force gradient is steep when pulling through and aft of stick neutral. Pull out checks were made from 1600 and 1200 rpm 24° hands off descents by first applying full forward stick (gave $53 V_o$) and smoothly and rapidly pulling aft to V_{min} . ($\Delta t = 4-5$ sec.) with a rapid force buildup and the nose on or slightly above the horizon at V_{min} ($40 V_o$). Descent to final was made at 1700 rpm, $48 V_o$, 800 fpm, power was added to 2200 rpm to make the runway and arrest excessive R/D. Power was reduced to 1800 rpm and full back stick still produced a bounce landing (400-500 fpm) but with main gear first. Suggested landing technique under those conditions - high rpm, flat and fly it on taking cut at rotation.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

1 hour and 5 minutes.

FLIGHT TIME:

45 minutes (+ 10 minutes taxi).

Flight Test Operation No. 164-24-2

Flex Wing Fleep, March 27, 1964

OBJECTIVES:

Flight envelope investigation at maximum gross weight and forward cg with higher wing incidence angles (24° , 25° and 26°).

CONFIGURATION AND CHANGES:

Gross weight 2313, cg 98.55. Wheel force instrumentation installed.

FLIGHT RESULTS AND COMMENTS:

Taxi runs and lift-offs were conducted at 25° and 26° i_w . Two lift-offs at 26° resulted in aborts and landing due to pitch-up at 43-44 mph which caused pull force decay from 30-40 pounds to near 0 as pitch occurred. Recovery was made by reducing power to idle and landing from 5-10 feet. This condition will be investigated more completely during later flights but seems to be part of a normal stall, especially at higher i_w . Speed power flight envelope checks were run at 24° and 25° i_w plus descent flare investigations.

DATA AND RECORDS:

Oscillograph plus ground observer records.

ENGINE TIME:

1 hour and 4 minutes.

FLIGHT TIME:

40 minutes (+ 10 minutes taxi).

Flight Test Operation No. 164-25-2

Flex Wing Fleep, March 31, 1964

OBJECTIVE:

Investigation of pitch at high i_w .

CONFIGURATION AND CHANGES:

Gross weight 2313 pounds, cg 98.55.

FLIGHT RESULTS AND COMMENTS:

Six taxi and lift-off runs 3-5 feet over runway were made; two each at 25, 25.5 and 26° i_w for purpose of investigating pitch-up and force reversal condition observed during last operation. No pitch was induced at 25°. Slight pitch with pull force decay from est. 15 pounds to 0 was experienced on the first of the two 25.5° runs. This condition was controlled in and out twice by recovering with abrupt forward stick (10-pound pulse). Pitch-up and force reversal was experienced on both 26° i_w runs at a more rapid rate and force decay than at 25.5°. We can arrest this condition with forward stick if caught soon enough. The second pitch could not be arrested and was coupled with right yaw and roll. At 26° i_w , this condition must be set up by flying near V_{min} 41-44 mph with about 20 pounds pull with entire sequence occurring rapidly (1-2 sec).

RATE AND RECORDS:

Oscillograph.

ENGINE TIME:

25 minutes.

FLIGHT TIME:

15 minutes (taxi only).

Flight Test Operation No. 164-26-2

Flex Wing Fleep, March 31, 1964

OBJECTIVES:

Check minimum speeds and stall characteristics.

CONFIGURATION AND CHANGES:

Gross weight 2316, cg 103.0.

FLIGHT RESULTS AND COMMENTS:

V_{min} investigation and nominal cg stability and control. Stall checks at 21, 22, 23, and 24° i_w produced V_{mins} slightly lower (.5 - 1 mph) than previously observed because full left stick was held against the right yaw for as long as possible. The machine simply quits flying and falls off in a right diving turn. 21 and 22° V_{min} is still defined by full back stick and max. pilot effort with no fall off. Stability and control was positive but sluggish as anticipated on all checks (static longitudinal - climb, cruise, and descent, dynamic long., maneuver stability check right and left, and bank to bank rolls). Light forces and max. two cycles.

Control power available in left roll is about 1/2 of right probably due to the 18° left out of rig condition of the wheel. Should be corrected to put us back in the center of our roll control envelope.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

1 hour.

FLIGHT TIME:

50 minutes.

Flight Test Operation No. 164-27-2

Flex Wing Fleep, April 3, 1964

OBJECTIVES:

Stability and control forward cg and maximum gross weight.

CONFIGURATION AND CHANGES:

Gross weight 2309, cg 98.55. ARC-27 radio installed, pilot control wheel re-rigged 25° right.

FLIGHT RESULTS AND COMMENTS:

Taxi and left-off checks conducted due to new cg calculations following heavy radio installation. Climb static and dynamic longitudinal checks conducted with positive and converging results. Maximum two cycles to damp from $V_{trim} - 4$ mph release. Trim response to large power variations also proved normal and positive with two cycles max. damp.

Static and dynamic longitudinal cruise, descent and maneuver tests also normal with high inherent system stability displayed. During rapid roll to roll maneuver checks using full wheel deflection, the abrupt increasing force gradient associated with moving the wing after full aileron deflection was felt. Wheel force required to move through this "artificial stop" goes from about 12 to 25 pounds at about the 1/2 wheel position. Very little adverse roll-yaw coupling is apparent during this exercise and the gradient automatically prevents the pilot from getting into lateral control trouble by over-banking. Turn radius is good enough for any purpose using aileron only with bank around 20-30° max.

Stall performance investigation at low rpm almost eliminated torque effect (right turn) as anticipated.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

52 minutes.

FLIGHT TIME:

40 minutes (+ 5 minutes taxi).

Flight Test Operation No. 164-28-2

Flex Wing Fleep, April 7, 1964

OBJECTIVES:

Stability and control aft cg, maximum gross weight.

CONFIGURATION AND CHANGES:

Gross weight 2309, cg 106.07.

FLIGHT RESULTS AND COMMENTS:

Conducted complete stability and program at aft cg similar to FTO 164-27-2. Damping and stability on all checks is positive and converging. Power effects checks holding V_{trim} required light forces with normal and positive results throughout power-thrust range. Additional stall investigations were made. Stalls at high power result in torque induced right turn followed by pull force decay and pitch-up which combines in a rolling turn to the right. Correction and recovery using forward stick and lift aileron with power as appropriate is quick and positive with attitude loss of 50 feet.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

52 minutes.

FLIGHT TIME:

45 minutes.

Flight Test Operation No. 164-29-2

Flex Wing Fleep, April 9, 1964

OBJECTIVES:

Speed power, climb and descent checks to provide additional data base for prop blockage performance tests.

CONFIGURATION AND CHANGES:

Gross weight 2285, cg 103. Control wheel centered.

FLIGHT RESULTS AND COMMENTS:

Flight was for purpose of re-establishing climb/descent and speed power points at $23^\circ i_w$ prior to installing cargo boxes for prop blockage tests. Data checks with previous recordings on flights under same conditions. H-34 chase provided photo coverage this flight. Inadvertantly flew into helicopter slip stream coming out of a 360° turn which provided another exercise in turbulence flying. The aircraft wallows but damps hands off as usual in turbulence.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

34 minutes.

FLIGHT TIME:

25 minutes.

Flight Test Operation No. 164-30-2

Flex Wing Fleep, April 9, 1963

OBJECTIVES:

Low cargo propeller blockage tests.

CONFIGURATION AND CHANGES:

Gross weight 2325, cg 103, two large cargo boxes installed across platform size 21.5 x 57 x 65 inches each.

FLIGHT RESULTS AND COMMENTS:

Two boxes were installed to provide low cargo shape prop. blockage. Taxi and lift-off runs were made at 22, 23, and 24° i_w . 23°, as anticipated, proved the optimum for T.O. General handling qualities, forces, speed power, etc. appear normal. However, rate of climb was noticeably less. The OAT was higher today than on any previous operation which may have some effect, but it appears that the only performance parameter seriously effected is reduction in rate of climb.

Nose gear strut went flat during taxi runs or on T.O which resulted in no pedal force for centering but ground station and chase helicopter reported normal wheel turning, so flight was continued. Landing into 8-10 K wind was made about 45° across runway in front of tower with no nose gear problem. Oleo strut leaked and collapsed on T.O.

DATA AND RECORDS:

Oscillograph and chase helicopter.

ENGINE TIME:

40 minutes.

FLIGHT TIME:

30 minutes.

Flight Test Operation No. 164-31-2

Flex Wing Fleep, April 10, 1964

OBJECTIVES:

High cargo propeller blockage tests.

CONFIGURATION AND CHANGES:

Gross weight 2345 pounds, cg 103. Three boxes installed elevating cargo height to about thrust line.

FLIGHT RESULTS AND COMMENTS:

General handling qualities, climb, descent, and maneuver was effected slightly as reported on the previous low blockage flight (FTO 164-30-2). Minimum speed checks suggest that the high prop. blockage masks torque effects at the stall with high rpm. In this configuration, the previously observed gentle right yaw at the stall is not present with pitch only present.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

45 minutes.

FLIGHT TIME:

40 minutes.

Flight Test Operation No. 164-32-2

Flex Wing Fleep, April 14, 1964

OBJECTIVES:

Practice takeoff and landing techniques for maximum performance.

CONFIGURATION AND CHANGES:

Gross weight 2285, cg 103.

FLIGHT RESULTS AND COMMENTS:

A series of take-offs and landings were made to determine best technique for max. performance using the Fairchild recorder and ground observers. Technique does not appear very critical in terms of ground roll, but will be optimized and reported on during later flights.

DATA AND RECORDS:

Fairchild camera plus ground observer measurements.

ENGINE TIME:

30 minutes.

FLIGHT TIME:

25 minutes.

Flight Test Operation No. 164-33-2

Flex Wing Fleep, April 15, 1964

OBJECTIVES:

Takeoff and landing performance at maximum gross weight.

CONFIGURATION AND CHANGES:

Gross weight 2285, cg 193.

FLIGHT RESULTS AND COMMENTS:

Six takeoffs and five landings were run for records with $i_w = 23^\circ$ holding 48 mph climb speed and landings at 1700, 1600, and 1500 rpm.

DATA AND RECORDS:

Fairchild camera plus ground observer measurements.

ENGINE TIME:

51 minutes.

FLIGHT TIME:

40 minutes.

Flight Test Operation No. 164-34-2

Flex Wing Fleep, April 15, 1964

OBJECTIVES:

Record rate of descent and flare performance using Army cinetheodolite system installed at Yuma Test Station.

CONFIGURATION AND CHANGES:

Gross weight 2285 pounds, cg 103.

FLIGHT RESULTS AND COMMENTS:

Three data runs were made at 1400 and 1200 rpm with full rotation and flare from stabilized forward stick V_{trim} . One additional run made at 1100 rpm but due to radio failure was not properly recorded. All rotations felt positive with sufficient elevator control power.

DATA AND RECORDS:

Oscillograph plus cinetheodolite coverage.

ENGINE TIME:

41 minutes.

FLIGHT TIME:

35 minutes.

Flight Test Operation No. 164-35-2

Flex Wing Fleep, April 16, 1964

OBJECTIVES:

Aft cg stability and control.

CONFIGURATION AND CHANGES:

Gross weight 2309 pounds, cg 106.07, min. rpm set at 900 static.

FLIGHT RESULTS AND COMMENTS:

Flight was a repeat due to previous instrumentation trouble. Safe, positive, converging stability under all test conditions was recorded. A descent check at idle (950 rpm) was conducted which produced a rate of descent of 950 fpm.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

44 minutes.

FLIGHT TIME:

35 minutes.

Flight Test Operation No. 164-36-2

Flex Wing Fleep, April 16, 1964

OBJECTIVES:

Record rate of descent and flare performance using Army cinetheodolite system installed at Yuma Test Station.

CONFIGURATION AND CHANGES:

Gross weight 2285 pounds, cg 103.

FLIGHT RESULTS AND COMMENTS:

Five data descents and rotations were conducted at 1400, 1200, 1000, 900, and 800 rpm. Observed rate of descent at 800 rpm is 1000 fpm with adequate elevator control power for rotation. Descent turns etc. at idle power are surprisingly smooth and easy; therefore, dead stick landing barring severe turbulence begin to look feasible.

DATA AND RECORDS:

Oscillograph plus cinetheodolite coverage.

ENGINE TIME:

42 minutes.

FLIGHT TIME:

30 minutes.

Flight Test Operation No. 164-37-2

Flex Wing Fleep, April 17, 1964

OBJECTIVES:

Descent checks as f(rpm).

CONFIGURATION AND CHANGES:

Gross weight 2285, cg 103, idle rpm static reset to 630.

FLIGHT RESULTS AND COMMENTS:

Only one climb and two descents at 1200 rpm were made before severe turbulence caused termination of the mission. As previously noted turbulence did cause some increase in descent rates. Heavy turbulence during final approach caused momentary air speed excursions between 58 and 39 mph with full forward stick most of the time to maintain speed. The system damps well in roll and yaw with only momentary impressions of marginal control. Effective pitch damping requires some stick control as noted but heavy turbulence technique remains essentially hands off and ride it out.

DATA AND RECORDS:

Oscillograph plus one practice takeoff for the Fairchild analyzer.

ENGINE TIME:

31 minutes.

FLIGHT TIME:

25 minutes.

Flight Test Operation No. 164-38-2

Flex Wing Fleep, April 20, 1964

OBJECTIVES:

Additional descent flare tests with helicopter chase observer. Takeoff and landings for Fairchild analyzer.

CONFIGURATION AND CHANGES:

Gross weight 2285 pounds, cg 103.0.

FLIGHT RESULTS AND COMMENTS:

A series of timed descents with close helicopter chase was conducted at low power (1200 rpm to idle 780) with simulated landing rotations. The chase observer reported positive rate of descent arrestment during every flare further confirming safe dead stick landing performance. Prop drag at idle probably causes slightly greater sink rates than actual dead stick condition where prop would stop.

Landings and takeoffs were performed with Fairchild camera coverage. Maximum performance landings using 1400 rpm on lower require full forward stick during last 100-200 feet of descent in order to have sufficient elevator control power for flare.

DATA AND RECORDS:

Oscillograph, Fairchild camera and chase helicopter.

ENGINE TIME:

1 hour and 22 minutes.

FLIGHT TIME:

1 hour and 5 minutes.

Flight Test Operation No. 164-39-2

Flex Wing Fleep, April 21, 1964

OBJECTIVES:

Light gross weight landing and takeoff performance for record.

CONFIGURATION AND CHANGES:

Gross weight 2025, cg 103.0. Instrumentation and power supply removed.

FLIGHT RESULTS AND COMMENTS:

Eight maximum performance takeoffs and eight landings conducted. One landing with complete pitchup and stall resulted in an estimated 17-ft. roll-out. This short distance resulted from sharp flare through stall and allowing the wing pitch-up phenomena to create further drag like a parachute. The trailing edge of the elevator can be scraped during this maneuver especially if back pressure is relaxed at high body angle. This maneuver seems safe and practical if really short landing is required.

Maximum performance takeoff technique following full power brake release is to briskly rotate at 35-37 mph which jumps the aircraft off at 40-42 mph with rapid speed buildup to about 50 mph before stabilizing at best climb speed of 47 mph. This data is for light gross weight, nominal, cg and $23^\circ i_w$ but would vary only slightly for other conditions.

DATA AND RECORDS:

Oscillograph, Fairchild camera and ground tape line measurements.

ENGINE TIME:

58 minutes.

FLIGHT TIME:

55 minutes.

Flight Test Operation No. 164-40-2

Flex Wing Fleep, April 22, 1964

OBJECTIVES:

Unprepared surface operation plus service and absolute ceiling test.

CONFIGURATION AND CHANGES:

Gross weight 2025 pounds, cg 103.0.

FLIGHT RESULTS AND COMMENTS:

Operated with no difficulty from desert "malapie" area about 600 by 200 ft. Surface was bumpy rocks and sand with tank and truck ruts running in all directions. Sustained max. power climb to 9100 ft. service and 9500 absolute ceiling with altimeter set at 29.92 was conducted. Time to climb to 9000 ft. was 25 minutes 51 seconds or an average of about 300 fpm. Stability, control and maneuver performance at 9000 ft. are normal. V_{max} and V_{min} are 49 and 42 mph. Climb to 8000 ft. was conducted at $i_w = 23^\circ$ and to ceiling at 24° . 2560 rpm (2790 max.) required for $F_e = 0$ trim cruise at 9500 ft.

DATE AND RECORDS:

Qualitative only.

ENGINE TIME:

1 hour and 19 minutes.

FLIGHT TIME:

1 hour.

Flight Test Operation No. 164-41-2

Flex Wing Fleep, April 22, 1964

OBJECTIVES:

Minimum speed checks at forward cg. Rough field operation.

CONFIGURATION AND CHANGES:

Gross weight 2025 pounds, cg 98.0.

FLIGHT RESULTS AND COMMENTS:

V_{min} for 24° , 23° , and $22^\circ i_w$ at 2500 ft. are 38.5, 39.5 and 41 mph limited by stall at 24° and 23° and full aft stick at $22^\circ i_w$. A series of landings and takeoffs in various cross and down wind conditions up to 15 K were made on the desert area described in FTO 164-40-2. Jeep trails and gravel roads were also used. Good demonstration of rough field characteristics. Most landings at idle rpm out of steep descents. One rotation timed at 3.5 seconds which is very good.

DATA AND RECORDS:

Qualitative only.

ENGINE TIME:

38 minutes.

FLIGHT TIME:

35 minutes.

Flight Test Operation No. 164-42-2

Flex Wing Fleep, April 23, 1964

OBJECTIVES:

Demonstration flight for U. S. Army, rough field operation.

CONFIGURATION AND CHANGES:

Gross weight 2285 pounds, cg 103.0. Instrumentation system reinstalled.

FLIGHT RESULTS AND COMMENTS:

Five takeoffs and landings on unprepared surface including several landings at idle power in winds of 10-14 K. Roll out distance often less than 25 ft. using standard technique. General low altitude handling and performance plus cross wind taxi was shown.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

29 minutes.

FLIGHT TIME:

25 minutes.

Flight Test Operation 164-43-2

Flex Wing Fleep, April 24, 1964

OBJECTIVES:

Initial ground handling and taxi checkout for U. S. Army TRECOM pilot.

CONFIGURATION AND CHANGES:

Gross weight 2265 pounds, cg 103.3.

FLIGHT RESULTS AND COMMENTS:

This period consisted purely of checkout, low and high speed taxi runs, and general ground handling familiarization. The nose wheel steering/one brake pedal/two wheel brake combination is effective and convenient to operate. The wing movement (produced by wind) is initially disturbing; however, it produces no effect to ground handling and the pilot quickly learns to ignore it.

Eight taxi runs were made on the inactive runway with the wind gradually increasing to 15 knots at the termination of the period. Variations of wing incidence angles of 22°, 23°, 24°, were made, and one run made while changing in from zero to 24°. The cross wind component was working at about 20-25° from the right while taxiing into the wind. Numerous turns and tacking maneuvers were made with the above-mentioned i_w . Low speed taxiing in these winds of 10-15 knots is completely satisfactory with the wing set at zero incidence angle and is not unsatisfactory with i_w 's of 22-24°.

High speed taxi runs were performed using progressive engine rpm's of 1600-1800. The last two runs into the quartering 12-15 knot wind produced a lateral scooting-sliding effect with 1800 rpm. Increasing the cross wind component by tacking had to be accompanied by reduction in power to keep it from scooting off the runway - no tip over tendency was experienced - just the scooting. Tacking directly into the wind produced a comfortable wing level zero lateral pressure situation - a feeling that the aircraft would like to fly itself off the ground.

DATA AND RECORDS:

None.

ENGINE TIME:

32 minutes.

FLIGHT TIME:

20 minutes (taxi only).

Flight Test Operation No. 164-44-2

Flex Wing Fleep, February 27, 1964

OBJECTIVES:

Pilot familiarization

CONFIGURATION AND CHANGES:

Gross weight 2265, cg 103.0.

FLIGHT RESULTS AND COMMENTS:

The entire period (164-44-2) consisted of a series of high-speed taxi runs beginning at 1600 rpm and progressing through lift-offs. Two each runs were made for $i_{W'S}$ of 22° , 23° , and 24° ; the latter of each using power setting at 2100 rpm. These conditions give directional trade-offs between the steerable nose wheel and control surfaces.

A number of lift-offs were accomplished at 2400-2600 rpm up to heights of 20-30 feet. Small "S" turns were done in keeping the bird over the white line. With the very light cross wind, it was a simple matter keeping it aligned; however, some effort was required to maintain a comfortable directional/wheels level position for touching down.

DATA AND RECORDS:

None.

ENGINE TIME:

45 minutes.

FLIGHT TIME:

45 minutes (taxi only).

Flight Test Operation 164-45-2

Flex Wing Fleep, April 27, 1964

OBJECTIVES:

Pilot familiarization.

CONFIGURATION AND CHANGES:

Gross weight 2265 pounds, cg 103.0.

FLIGHT RESULTS AND COMMENTS:

Takeoff and climb to 4000 feet was made using max. power at $F_e = 0$, $V_t + 2$, and $V_t - 2$. General handling fam. was conducted at altitude using approx. 1/2 wheel for turns. V_{max} check was made at $22^\circ i_w$, full power, and full forward stick. Only a slight aileron oscillation was detected. V_{min} check was made at 2400 rpm, $23^\circ i_w$, using full aft stick. Considerable time was required for V_i to reduce and as the airspeed dropped off, left wheel was required to hold heading against the torque reaction. At 41 mph (ind.) the aircraft gently fell off to the right in a smooth turning descent. Recovery by relaxing control force was rapid with a minimum loss of altitude (40') and airspeed (5 mph).

Descent into the traffic pattern was conducted at various power settings. Terminated by a shallow approach and landing. During the last portion of the approach while making corrections for the slight cross wind, a wing-deck system inter-reaction was induced by over controlling. This condition was not experienced on the high speed lift-off runs. Only slight attention is required to prevent this over-correcting. I suspect fastening the wing rigidly to the main body structure will eliminate any such pilot induced inter-reaction characteristic.

Handling qualities while airborne are conducive to pilot relaxation. Utilizing $F_e = 0$ and attentive power control technique produces a pleasant general feel for control.

DATA AND RECORDS:

None.

ENGINE TIME:

55 minutes.

FLIGHT TIME:

45 minutes.

Flight Test Operation No. 164-46-2

Flex Wing Fleep, April 28, 1964

OBJECTIVES:

Complete U. S. Army pilot check-out.

CONFIGURATION AND CHANGES:

Gross weight 2265, cg 103.3.

FLIGHT RESULTS AND COMMENTS:

Familiarization was the test objective however, 8 data points were also taken. The climb to altitude was made with $i_{w's}$ of 22°, 23° and 24° and $F_e = 0$. Full wheel turns required much pressure upon exceeding the limit of aileron control, but turns which require more than aileron control should never be required for ordinary maneuvers.

Descents with reduced power terminated by pull-ups produced two hairy pucker-type stalls. Aft stick was held until the nose fell well through holding the wings relatively level. This produced a pronounced nose-down attitude followed by a corresponding nose high attitude. Two to three cycles were required to completely damp to V_{trim} . Both power and elevator were used in recovery.

The flight terminated with five reduced-power flare landings. These landings were quite similar to autorotative landings for wheeled helicopters. Power settings of 1600-1100 rpm were held until just before touchdown. The flare was applied early on landing number two, and the stall-pitchup was experienced. Airspeed decayed suddenly (hi drag) while the nose was up; and the aircraft settled evenly on the main gear. These landings took place in no-wind conditions, produced no lateral directional difficulty, and were, in general, relatively comfortable. Tail power for establishing the landing attitude was completely adequate and responsive for the rates of descent and airspeeds experienced.

Maximum performance takeoffs were also experienced as well as fairly tight traffic pattern maneuvering. Some turbulence was noted at altitude. The aircraft has an over-all stable feeling, although, this pilot found himself holding forward stick pressure throughout the familiarization period.

DATA AND RECORDS:

Oscillograph.

ENGINE TIME:

1 hour and 10 minutes.

FLIGHT TIME:

1 hour.

Flight Test Operation No. 164-47-2

Flex Wing Fleep, April 28, 1964

OBJECTIVES:

Initial wing fixed taxi and lift-off tests. Aileron only for lateral control.

CONFIGURATION AND CHANGES:

Gross weight 2285 pounds, cg 103.0. Wing fixed relative to body by cross cable system.

FLIGHT RESULTS AND COMMENTS:

Flight was conducted to take a preliminary look at system effectiveness with the wing fixed, using aileron control only. Two low speed taxi runs were made at 30 mph V_0 with aileron action apparently normal. Two high speed runs were conducted at 40 mph V_0 with no lift-offs. Available lateral control power to the left is about 1/2 of control power to the right. Wheel indicates 20° against stop to left and 45° to right. This may be simply wheel rigging again, but the net effect in flight is to create the impression of marginal left turn capability and adequate right turn control power. Four lift-off runs were made in 6K of wind the length of the active runway with gradually increasing bank angles and S turns at 5-20 feet altitude. This phase of the operation established the fact that operation of a flex wing vehicle with aileron only is feasible, but control power for anything but calm or steady wind is marginal with this particular configuration. With wing fixed, the material stretches quite noticeably against the air load, but feels OK except for limited and unsummetric wheel travel. Response rates appear more sluggish than with wing free. During a runway discussion with the ground personnel, the wing was rolled to max. i_w by one of them, and I failed to notice it which resulted in an interesting takeoff. With wing at 28°, acceleration was poor; and the vehicle pitched up extremely high with tail scraping before run was aborted. On the next high speed taxi attempt a sharp gust from the right caused momentary loss of directional control. Available lateral control power simply was not enough to straighten out as could have easily been done with wing free. Recovery was done through kicking nose wheel left with drift and then right to regain directional control.

A design analysis and possible modifications like more aileron travel should be conducted before resuming fixed wing flights.

DATA AND RECORDS:

Oscillograph and film coverage.

ENGINE TIME:

40 minutes.

FLIGHT TIME:

35 minutes (taxi only).



DEPARTMENT of DEFENSE

Directorate for Freedom of Information and
Security Review, Room 2C757
1155 Defense Pentagon
Washington, DC 20301-1155

Facsimile Transmittal

30 November 2001

To: Mr. Larry Downing

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Total Pages Transmitted (including cover sheet): 04

Comments: I am forwarding the FOIA request DTIC received, the DTIC forwarding letter, and a list of documents. The documents in the attached list have been released to a FOIA requester [under our case number 01-F-2458] and are, therefore, cleared for public release. If you have questions, give me a call.

AMERICAN LAWYER MEDIA

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01-F-2458

April 11, 2001

Defense Technical Information Center
Attn: Kelly Akers, FOIA Manager
8725 John J. Kingman Road Suite 0944
Fort Belvoir, VA 22060-6218

FOIA REQUEST

Dear Ms. Akers:

American Lawyer Media respectfully requests, under the Freedom of Information Act, a copy of each of the following records:

- AD B253477, XV-8A Flexible Wing Aerial Utility Vehicle, by H. Kredit, January 1964, 144 pages
- AD B252433, Pilot's Handbook for the Flexible Wing Aerial Utility Vehicle XV-8A, March 1964, 52 pp
- AD B200629, Flex Wing Fabrication and Static Pressure Testing, by Larry D. Lucas, June 1995, 80 pages
- AD B198352, Materials Analysis of Foreign Produced Flex Wings, by Albert Ingram, March 1995, 16 pp.
- AD B131204, Active Flexible Wing Technology, by Gerald D. Miller, Feb. 1988, 256 pages
- AD B130217, Producibility Analysis of the Alternative Antitank Airframe Configuration Flex Wing, June 1988, 112 pages
- AD B126450, From Delta Glider to Airplane, June 1988, 5 pages
- AD B803668, Sailwing Wind Tunnel Test Program, September 1966, 125 pages
- AD 477 482, An Evaluation of Flex-Wing Aircraft in Support of Indigenous Forces Involved in Counterinsurgency Operations by R.A. Wise, Feb 1965, 74 pages
- AD 461202, XV-8A Flexible Wing Aerial Utility Vehicle, H. Kredit, Feb. 1965, 100 pages
- AD 460405, XV-8A Flexible Wing Aerial Utility Vehicle, Final Report, Feb. 1965, 113 pages
- AD 431128, Operational Demonstration and Evaluation of the Flexible Wing Precision Drop Glider in Thailand, by William R. Quinn, November 1963, 22 pages.
- AD 430150, Comparative Evaluation of Republic Bikini Drone System, Final Report, 1943?

We agree to pay up to \$200 for costs associated with this request. We are grateful for your kind assistance in this matter. Please contact me at 212-313-9067 if you have any questions relating to our request.

Sincerely,



Michael Ravnitzky
Editor

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